INSTRUCTION MANUAL

Type 1192/Z

Counter

PRELIMINARY MANUAL

GENERAL RADIO

WARRANTY

We warrant that each new instrument manufactured and sold by us is free from defects in material and workmanship and that, properly used, it will perform in full accordance with applicable specifications for a period of two years after original shipment. Any instrument or component that is found within the two-year period not to meet these standards after examination by our factory, District Office, or authorized repair agency personnel will be repaired or, at our option, replaced without charge, except for tubes or batteries that have given normal service.

Type 1192/Z

Counter

PRELIMINARY MANUAL

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West Concord, Massachusetts, U.S.A. 01781
Form No. 1192-0100
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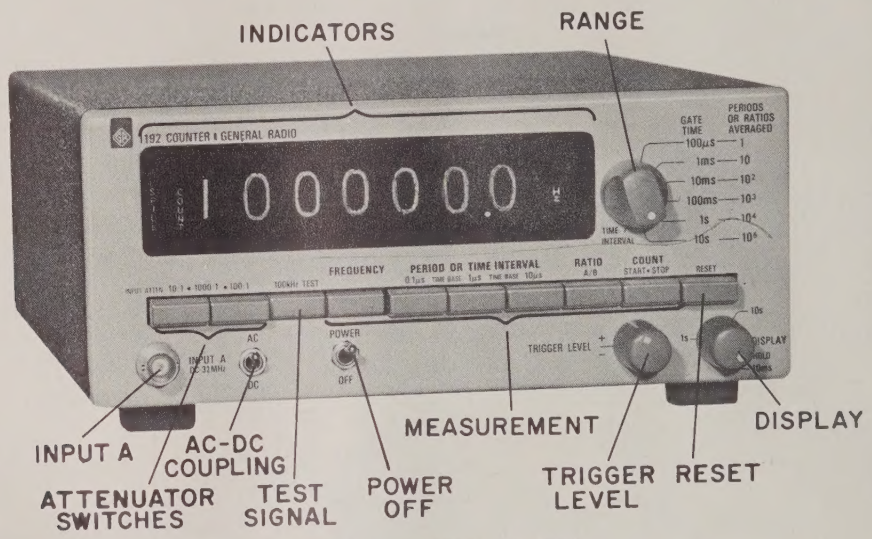
ID-B100

Condensed Operating Instructions



Type 1192 Counter (P/N 1192-9708).

To perform a measurement with the 1192 Counter, proceed as follows:

a. Connect the input signal to be measured to the INPUT A connector (use INPUT ATTEN pushbuttons, if necessary). If a RATIO measurement is to be made, connect the second signal to the INPUT B connector. If an external standard frequency is to phase lock the counter, connect it to INPUT B and set the EXT TIME BASE switch to the proper position.

b. Check that the line-voltage switch is in the proper position.

c. Set the AC-DC switch to the desired position.

d. Set the INPUT ATTEN buttons to 10:1 or 100:1.

e. Center the TRIGGER LEVEL control.

f. Switch the POWER-OFF switch to the POWER position.

g. Set the range switch to the desired counting time or number of periods or ratios averaged.

h. Set the DISPLAY control to the desired display time.

i. Depress the desired measurement pushbutton. If a TIME INTERVAL measurement is to be made, set the range switch to TIME INTERVAL and depress one of the TIME INTERVAL pushbuttons. If a COUNT measurement is to be made, do not depress the COUNT pushbutton until it is desired to start the measurement.

j. Depress the STORAGE pushbutton on the rear panel, if the storage mode is not desired, but leave it unlatched if storage is desired.

k. Connect any desired data-reading instruments to the optional DATA OUTPUT connector on the rear panel. The decimal point and range information will not be printed out, just the numerals of the answer.

l. Depress the RESET button, release it and read the answer to the measurement on the front-panel visual registers, after the amount of time set on the range switch has elapsed. Measurements will continue to be made if the DISPLAY control is in any position except HOLD. If a measurement reading does not appear or is erratic adjust the TRIGGER LEVEL control or decrease the INPUT ATTEN setting.

1192-Z Operating Instructions

To operate the 1192-Z Counter, proceed as follows:

a. Connect the 6-in. coaxial cable supplied (P/N 0776-2000) with the 1192-Z between the 10:1/100:1 OUT connector on the 1157-B Scaler and the INPUT A connector on the 1192 Counter.

b. Check that the line-voltage switches on both the scaler and counter are each in the proper position for the voltage available.

c. Connect the power cords supplied between the power source and the instruments.

d. Turn the 1157 SENSITIVITY control left to its stop, initially.

e. Connect the signal to be measured to the INPUT connector (maximum level, 7 V rms).

f. Set the MULTIPLY COUNTER READING BY switch to the desired ratio. The pilot light should glow.

g. Turn the SENSITIVITY control cw, as required, to obtain an indication in the green sector of the INPUT LEVEL meter. More detailed instructions are given in the 1157 Instruction Manual, Operation Section.

h. Set the AC-DC switch to the AC position on the 1192 Counter.

i. Set the INPUT ATTEN buttons to 10:1 or 100:1.

j. Center the TRIGGER LEVEL control.

k. Set the POWER-OFF switch to the POWER position.

l. Set the range switch to the desired counting time or number of periods or ratios averaged.

m. Set the DISPLAY control to the desired display time.

n. Depress the desired measurement pushbutton. If a TIME INTERVAL measurement is to be made, set the range switch to TIME INTERVAL and depress one of the TIME INTERVAL pushbuttons. If a COUNT measurement is to be made, do not depress the COUNT pushbutton until it is desired to start the measurement. If a RATIO measurement is to be made, connect the second signal (lower frequency) to the INPUT B connector on the rear panel of the 1192. If an external standard frequency is to phase lock the counter, connect it to INPUT B and set the EXT TIME BASE switch to the proper position. A RATIO measurement and a phase-locked counter can not exist at the same time.

o. Depress the STORAGE pushbutton on the rear panel if the storage mode is not desired, but leave it unlatched if storage is desired.

p. Connect any desired data-reading instruments to the optional DATA OUTPUT connector on the rear panel of the 1192.

q. Depress the RESET button, release it and read the answer to the measurement (remember to allow for the X10 or X100 scaling factor) on the front-panel visual registers, after the amount of time set on the range switch has elapsed. Measurements will continue to be made if the DISPLAY control is in any position except HOLD. If a measurement reading does not appear or is erratic, check that the scaler INPUT LEVEL reading is in the green range and adjust the TRIGGER LEVEL control or decrease the INPUT ATTEN setting on the counter.

More detailed counter instructions are given in the 1192 Operation section of this manual.

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Introduction—Section 1

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1.1 PURPOSE.

The 1192 is a general-purpose, dc to 32-MHz counter-timer for the measurement of frequency, period, frequency ratio, time interval, and number of events.

1.2 DESCRIPTION.

The counter employs a five-, six-, or seven-digit visual register comprised of high-intensity gas-readout tubes containing 0.510-in. high digits, with automatic display of decimal point and measurement dimensions. An internal storage feature provides a continuous display of corrected data without flicker.

Models are available with high-speed buffered 1-2-4-8 BCD outputs from the internal storage to drive auxiliary data-handling equipment.

INPUT A has a high-impedance, low-noise FET circuit preceded by a four-position step attenuator. Controls for trigger level, polarity, and coupling are also provided. The 1-MΩ input impedance of INPUT A is independent of control settings and thus permits the use of general-purpose, low-capacitance oscilloscope probes.

INPUT B has a 10-kΩ input impedance, 50-Hz to 10-MHz frequency range and a fixed trigger level.

1.3 CONTROLS, CONNECTORS AND INDICATORS.

Figure 1-1 shows and Table 1-1 identifies the front-panel controls, connectors and indicators. Figure 1-2 shows and Table 1-2 identifies the rear-panel controls and connectors.

1.4 ACCESSORIES SUPPLIED.

Table 1-3 lists the accessories supplied with the 1192 Counter.

1.5 EQUIPMENT AVAILABLE.

1.5.1 500-MHz Frequency Range.

To extend the upper frequency to 500 MHz, the counter can be used with the 1157-B Scaler. The scaler is a completely self-contained 500-MHz direct-counting frequency divider with 10:1 and 100:1 division. Together with this prescaler, (Figure 1-3) the 1192 frequency range is extended to 320 MHz in the 10:1 position and 500 MHz in the 100:1 position. The input sensitivity of the prescaler is better than 100 mV rms and 300 mV pk-pk.

1.5.2 Signal Scanning.

To automatically and sequentially connect a number of signals for measurement, the counter can be used with the 1770 Scanner System. The scanner selects one of up to 100 signals (dc to 100 MHz) and presents it to the counter for measurement. The number of channels, the number of lines switched per channel, and the line terminations can be varied to suit the application and a high-temperature cable (−75 to +250°C) can be supplied to connect to components in an environmental chamber.

1.5.3 Greater Accuracy.

For greater stability and accuracy, the counter can be used with the 1115 Standard-Frequency Oscillator. The oscillator provides an output of 1 V rms into 50 Ω at frequencies of 100 kHz, 1 MHz, and 5 MHz. The oscillator signal is fed into INPUT B to phase lock the counter oscillator.

1.5.4 Digital Recording.

For digital records of the measurement data, counters with the data output option can be used with the 1137 Data Printer. The printer records up to twelve columns at print rates up to three lines per second.

1.5.5 Analog Output and X-Y Recording.

For analog measurement data, counters with the data output option can be used with the 1136 Digital-to-Analog Converter. The converter changes the digital data from the counter to a voltage or current proportional to the numerical value of any three consecutive digits or the last two digits of data. Storage circuits in the converter permit use with intermittent as well as continuous BCD data. If an X-axis input is provided, an X-Y recorder can then be used to record the measurements vs temperature or voltage, etc.

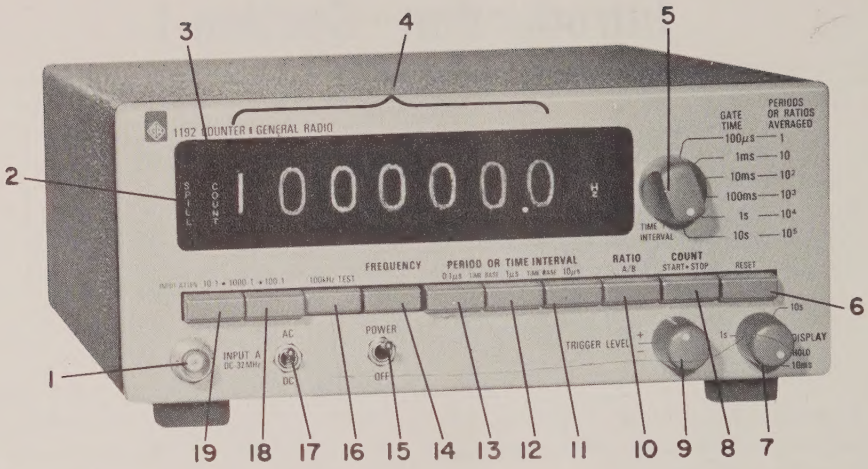


Figure 1-1 Front-panel controls, connectors and indicators (P/N 1192-9708).

Table 1-1
FRONT-PANEL CONTROLS, CONNECTORS, AND INDICATORS

Fig. 1-1 Ref.	Name	Description	Function
1	INPUT A DC-32 MHz	BNC connector, socket (A-J1)	Input signal connector for channel A.
2	SPILL	Incandescent lamp	Lights when most significant digit is greater than nine, indicating overflow.
3	COUNT	Incandescent lamp	Lights when measurement is in progress.
4	– – – –	Visual register	High-intensity gas readout tubes that provide visual indication of measurement value, including the decimal point.
5	Range	Seven-position range switch (C-S1)	Used to set GATE TIME, PERIODS OR RATIOS AVERAGED or TIME INTERVAL.
6	RESET	One-position push-button switch (B-S1K)	Resets the counter to zero.

1-2 INTRODUCTION

Table 1-1 (cont)

FRONT-PANEL CONTROLS, CONNECTORS, AND INDICATORS

Fig. 1-1 Ref.	Name	Description	Function
7	DISPLAY	Rotary knob control with switch at ccw end (A-R1, A-S4)	Establishes the time for the display before the next measurement is taken.
8	COUNT START–STOP	Two-position push-button switch (B-S1J)	Initiates count measurements when depressed; terminates count measurement when released.
9	TRIGGER LEVEL	Rotary knob control (A-R2)	Sets trigger level of INPUT A signal.
10	RATIO A/B	Two-position push-button switch (B-S1H)	Causes counter to measure the ratio between the INPUT A and B signals when depressed.
	PERIOD OR TIME INTERVALS		
11	10 μs	Two-position push-button switch (B-S1G)	Causes counter to measure the period or time interval at 10 μs increments when depressed.
12	1 μs	Two-position push-button switch (B-S1F)	Causes counter to measure the period or time interval at 1 μs increments when depressed.
13	0.1 μs	Two-position push-button switch (B-S1E)	Causes counter to measure the period or time interval at 0.1 μs increments when depressed.
14	FREQUENCY	Two-position push-button switch (B-S1D)	Causes counter to measure the frequency of the INPUT A signal when depressed.
15	POWER-OFF	Two-position toggle switch (A-S1)	Applies line voltage to instrument.
16	100 kHz TEST	Two-position push-button switch (B-S1C)	Applies a 100-kHz signal internally to the counter for checking its operation.
17	AC – DC	Two-position toggle switch (A-S2)	Selects either ac or dc coupling for the INPUT A signal.
18	INPUT ATTEN 100:1	Two-position push-button switch (B-S1B)	Attenuates the INPUT A signal 100:1 when depressed.
19	10:1	Two-position push-button switch (B-S1A)	Attenuates the INPUT A signal 10:1 when depressed.
—	1000:1	Depress both the 100:1 and 10:1 switches.	Attenuates the INPUT A signal 1000:1

Table 1-2
REAR-PANEL CONTROLS AND CONNECTORS

Fig. 1-2 Ref.	Name	Description	Function
1	FUSE	Extractor-post fuse holder (A-F1)	Contains 3/10-A fuse for 100- to 125-V operation.
2	FUSE	Extractor-post fuse holder (A-F2)	Contains 15/100-A fuse for 200- to 250-V operation.
3	100 V-125 V, 200 V-250 V, 50-400 Hz	Two-position slide switch, screwdriver operated (A-S3)	Selects line voltage.
4	DATA OUTPUT	Fifty-pin connector (optional) accepts Cinch or Amphenol P/N 57-30500 Multiple Plug (D-J1)	Supplies 1-2-4-8 BCD measurement data and control signals to external equipment (Figure 2-3).
5	INPUT B	BNC connector, jack (A-J3)	Input connector for channel B. Used for ratio measurements or external oscillator locking.
6	STOP	BNC connector, jack (A-J4)	Accepts a negative pulse to stop TIME INTERVAL measurement or close the gate after a COUNT measurement.
7	START	BNC connector, jack (A-J5)	Accepts a negative pulse to start a TIME INTERVAL measurement or open the gate for a COUNT measurement.
8	EXT TIME BASE 100 kHz (IN) 1 MHz (OUT)	Two-position push-button switch (B-S2B)	When switch is depressed the internal oscillator will lock to a 100-kHz signal applied to INPUT B. When in the released position, the internal oscillator will lock to a 1-MHz signal applied to INPUT B.
9	STORAGE ON (OUT) OFF (IN)	Two-position push-button switch (B-S2A)	When STORAGE switch is unlatched storage circuits are activated and the measurement is displayed during the display cycle as well as the measurement cycle. When depressed the storage circuits are disabled and the count will be displayed according to the front-panel DISPLAY switch.
10	—	Power plug, 3-wire (A-J2)	Accepts 3-wire ac line cord to power instrument.

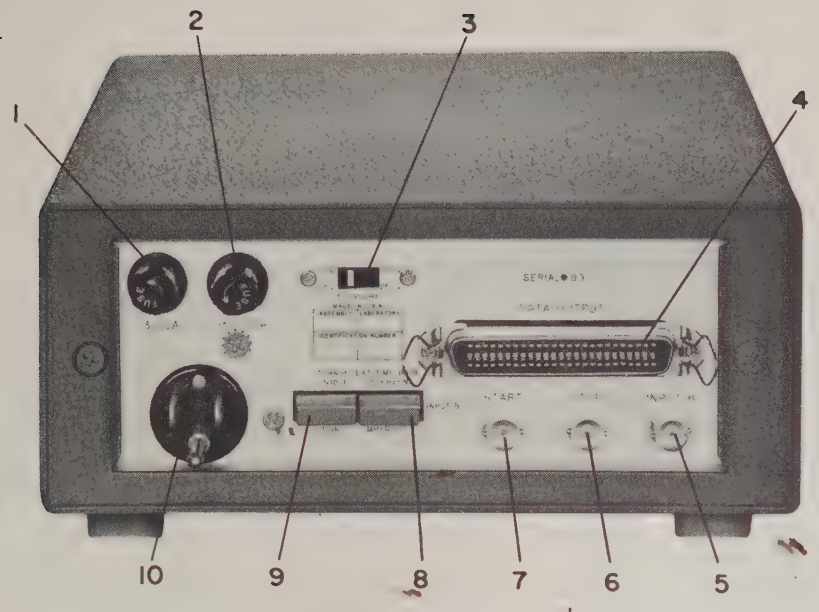


Figure 1-2 Rear-panel controls and connectors (P/N 1192-9710).

Table 1-3
ACCESSORIES SUPPLIED

Name	Description	GR Part Number
Power Cord	7-foot, 3-wire	4200-9622
Rack Adaptor Set*	———	0480-9722

*Supplied with rack-mount instruments only.

1.5.6 DC Recording.

For dc records of the measurement data, counters with the data output option can be used with the 1136 Digital-to-Analog Converter and a 1521 Graphic Level Recorder. The recorder provides a 4-in. wide continuous recording with an accuracy of ±1% full scale, a resolution of ±0.25% of full scale, and recording speeds of from 2.5 in. per hour to 75 in. per minute.

1.5.7 Systems.

Since additional equipment can expand the basic capability of the 1192 Counter to a complete measurement facility, General Radio has arranged to supply complete systems and inquiries are invited. Each system is custom tailored to individual requirements and includes only the equipment necessary to perform the required task; completely assembled and checked as a unit.

Such systems have wide application and can be used for laboratory development, production monitoring, final quality assurance, production-lot sorting, incoming inspection, environmental testing, reliability evaluation, etc., on an automatic or semi-automatic basis.

1.5.8 Line-Voltage Regulation.

The GR 1591 Variac® Automatic Voltage Regulator is available to stabilize the line-voltage input.

1.6 PATCH CORDS AND ADAPTORS.

Table 1-4 lists some General Radio patch cords and adaptors that can be used with the 1192. Consult the latest General Radio Catalog for a complete list.

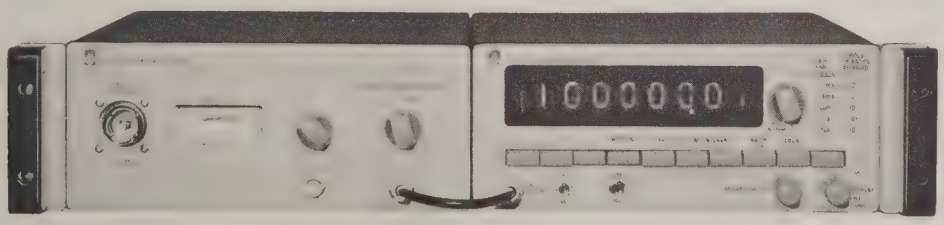
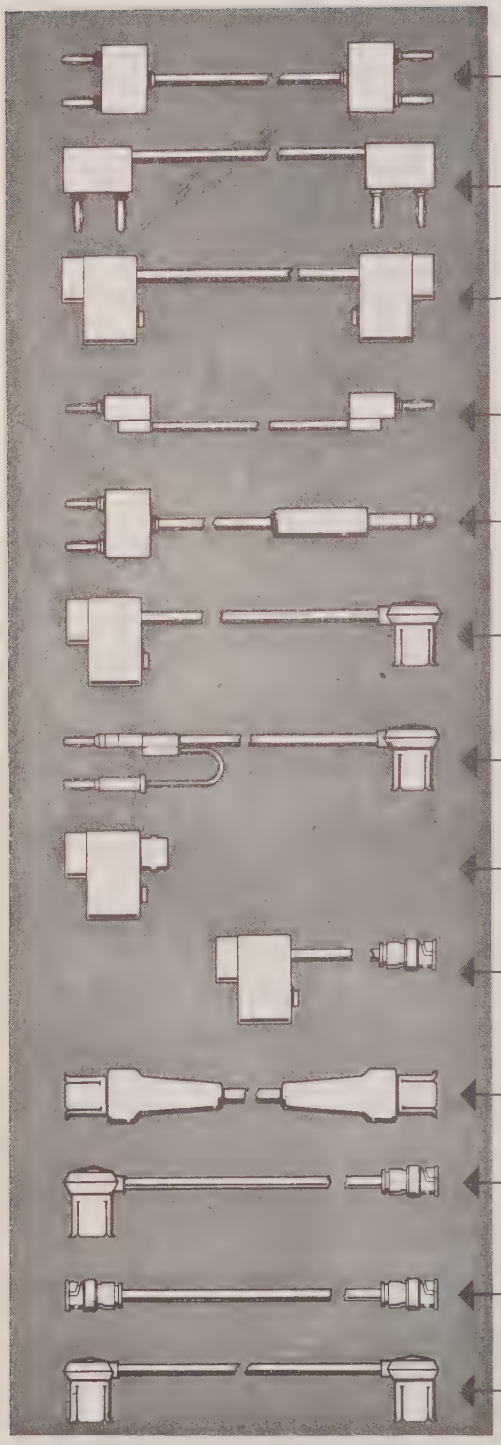


Figure 1-3 1192 Counter and 1157-B Scaler in a rack-mount configuration.

Table 1-4

AVAILABLE INTERCONNECTION ACCESSORIES



TYPE NO.	DESCRIPTION	CATALOG NO.
274-NQ	Double-plug patch cord, in-line 36" long	0274-9860
274-NQM	Double-plug patch cord, in-line 24" long	0274-9896
274-NQS	Double-plug patch cord, in-line 12" long	0274-9861
274-NP	Double-plug patch cord, right-angle 36" long	0274-9880
274-NPM	Double-plug patch cord, right-angle 24" long	0274-9892
274-NPS	Double-plug patch cord, right-angle 12" long	0274-9852
274-NL	Shielded double-plug patch cord, 36" long	0274-9883
274-NLM	Shielded double-plug patch cord, 24" long	0274-9882
274-NLS	Shielded double-plug patch cord, 12" long	0274-9862
274-LLB	Single-plug patch cord, black, 36" long	0274-9468
274-LLR	Single-plug patch cord, red, 36" long	0274-9492
274-LMB	Single-plug patch cord, black, 24" long	0274-9847
274-LMR	Single-plug patch cord, red, 24" long	0274-9848
274-LSB	Single-plug patch cord, black, 12" long	0274-9849
274-LSR	Single-plug patch cord, red, 12" long	0274-9850
1560-P95	Adaptor cable, double-plug to telephone plug, 36"	1560-9695
874-R34	Coaxial patch cord, double plug to GR874, 36" long	0874-9692
874-R33	Coaxial patch cord, two plugs to GR874, 36" long	0874-9690
274-QBJ	Adaptor, shielded double plug to BNC jack	0274-9884
776-A	Patch cord, shielded double plug to BNC plug, 36" long	0776-9701
874-R22A	Coaxial patch cord GR874 to GR874, 36" long	0874-9682
776-B	Patch cord, GR874 (right-angle) to BNC plug, 36" long	0776-9702
776-C	Patch cord, BNC plug to BNC plug, 36" long	0776-9703
776-D	GR874 to GR874, both right-angle, 36" long	0776-9704

274-13XA

Installation—Section 2

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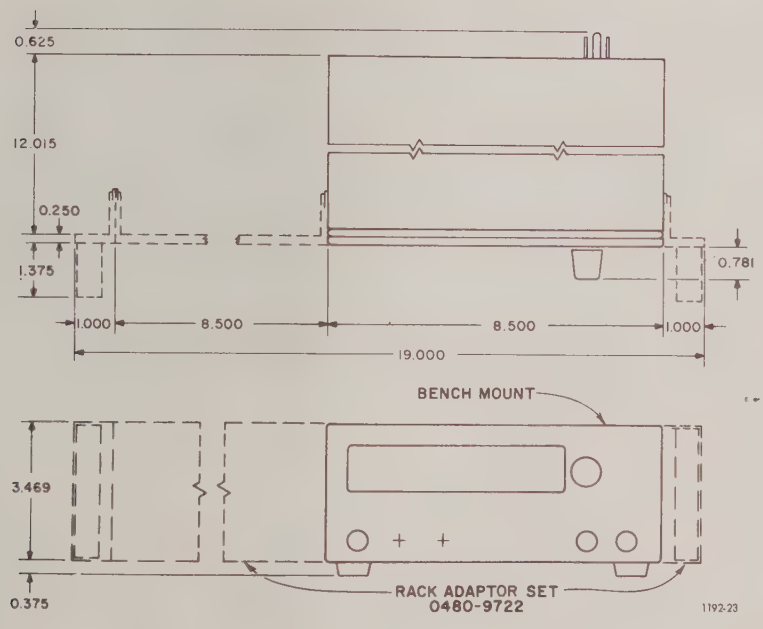

Figure 2-1 Dimensions of the 1192 Counter (inches).

2.1 DIMENSIONS.

Figure 2-1 shows the dimensions of both the bench- and rack-mount counter.

2.2 POWER CONNECTIONS.

The wiring of the power transformer can be switched, by means of the 2-position slide switch (3, Figure 1-2) on the rear panel, to accept 50- to 400-Hz line power of either 100- to 125-V or 200- to 250-V.

Connect the 3-wire power cable (P/N 4200-9622) supplied to the line and to the 3-terminal male connector (10, Figure 1-2) on the rear panel. A 0.15-A fuse is used in the 200- to 250-V circuit; a 0.3-A fuse in the 100- to 125-V circuit. The proper fuse is connected by the slide switch. Power consumption is approximately 22 W.

2.3 BENCH USE.

The instrument is delivered completely assembled in a metal cabinet, ready for bench use. A convenient bail, located between the front feet, can be pulled down to raise the front of the instrument and provide a better view of the control settings.

2.4 RELAY-RACK MOUNTING.

2.4.1 Single Instrument and Blank Panel (Figure 2-2).

Rack Adaptor Set (P/N 0480-9722) is available to convert the portable bench model for use in an EIA standard RS-310 19-in. relay rack with universal mounting-hole spacing. Table 2-1 lists the parts included in the Rack Adaptor Set. The conversion procedure is as follows (Figure 2-2):

a. Loosen the two captive 10/32 screws in the rear of the cabinet, near the sides, until the instrument is free; slide the instrument forward, out of the cabinet.

b. Remove the four feet from the cabinet. Simply push out the two rear feet. Spread the bail (A, Figure 2-2) slightly and the two front feet (B) and the bail will drop out. Be sure to save all parts for possible reconversion of the instrument to bench mounting.

c. Push out the plugs from the four bosses (C) on the sides of the cabinet, near the front. Use a hammer and a small punch inside the cabinet to push each plug outward. Do not damage the threads in the threaded holes.

d. Press the subpanel (D) into the blank panel (E), to form a liner for the latter.

e. Attach the short flange of the blank panel to the front of the cabinet (on either side of the cabinet, as desired) using two 5/16-in. screws (F). Note that the screws enter in opposite directions — one from inside the cabinet and one from the flange side, as shown.

f. Pierce and push out the plug in the lower rear boss (G) on the side toward the blank panel only, as shown.

g. Attach one end of the support bracket (H) to the lower rear boss. The bracket must be placed so that the screw passes through a clearance hole, into a tapped hole. Lock the bracket in position with a 5/16-in. screw (J).

h. Attach the other end of the support bracket to the lower, rear hole in the wide flange, as shown, using a 5/16-in. screw (K).

i. Attach one Rack Adaptor Assembly (Q, including handle) to the side of the cabinet opposite the blank panel, using two 5/16-inch screws (L). Again, note that the screws enter in opposite directions, one from inside the cabinet and one from outside. Use the upper and lower holes in the assembly.

j. Attach the other Rack Adaptor Assembly (Q, including handle) to the wide flange on liner (D) and the flange on the blank panel (E). Use two 5/16-in. screws (M) through the two holes in the flange that are nearest the panel and through the upper and lower holes in the assembly. Again, the screws enter in opposite directions.

k. Install the instrument in the cabinet and lock it in place with the two captive screws through the rear panel that were loosened in step a.

l. Place a straight edge across both the instrument panel and the blank panel. Loosen the screw (J) through the slot in the support bracket (H). Exert a slight pressure on the blank panel (E) so that it forms a straight line with the instrument panel, and tighten the screw (J) in the bracket, to lock the panels in this position.

m. Slide the entire assembly into the relay rack and lock it in place with the four 9/16-in. screws (N) with captive nylon cup washers. Use two screws on each side and tighten them by inserting a screwdriver through the holes (P) in the handles.

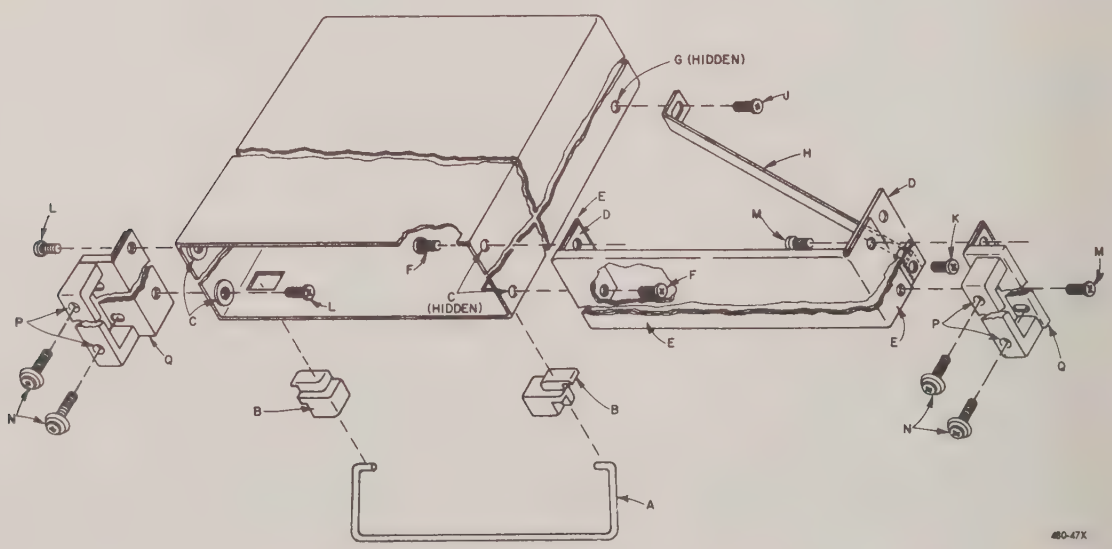

Figure 2-2 Method of mounting the counter and a blank panel in a relay rack.

Table 2-1
PARTS INCLUDED IN THE RACK ADAPTOR SET,
P/N 0480-9722 (Figure 2-2)

Fig. 2-2 Ref.	No. Used	Item	GR Part No.
E	1	Blank Panel	0480-8932
D	1	Sub-Panel	0480-8952
Q	2	Rack Adaptor Assembly	0480-4902
H	1	Support Bracket	0480-8524
—	1	Hardware Set includes	0480-3080
F, J, K, L, M,		8 Screws, Phillips head 10-32, 5/16 in.	
N		4 Screws, Phillips head, 10-32, 9/16 in. with white nylon cup washers	

2.4.2 Reconverting to Portable Bench Mounting.

To reconvert the instrument for bench use, reverse the procedure, first removing the entire assembly installation of instrument, cabinet, and blank panel from the rack.
Next remove:

a. The instrument from its cabinet.

b. The support bracket (H) from the cabinet (Figure 2-2).

c. The blank panel (E) (with handle attached) from one side of the cabinet.

d. The Rack Adaptor Set (handle) from the other side of the cabinet.

Push the two rear feet into the cabinet; slide the bail (A) and two front feet (B) into place. Install the instrument in its cabinet and lock it in place with the two captive screws through the rear panel.

CAUTION

Be careful that the DATA OUTPUT clamps don't get jammed inside the cabinet.

2.4.3 Rack-mounting Two Instruments.

Two instruments of the same panel size (such as two 1192 counters or one 1192 and an 1157-B Scaler 500 MHz) can be mounted side-by-side in a standard 19-in. relay rack. Use the mounting procedure, substituting the second instrument for the blank panel. Do not use the support bracket (H, Figure 2-2), but insert three screws through the bosses in the adjacent sides of the cabinets, two near the front (C) and one near the rear (G). The four feet and the bail must, of course, be removed from each cabinet. Use the four screws (N) with nylon washers to lock the instruments in the rack. The required hardware is listed below:
3 Screws, Phillips head, 10-32, 5/16
4. Screws, Phillips head, 10-32, 9/16 with nylon washers

NOTE

When mounting the 1192 Counter and the 1157-B Scaler side-by-side, the 1157-B should be mounted to the left of the 1192 as seen from the front (Figure 1-3).

2.5 DATA OUTPUT SOCKET (OPTIONAL).

2.5.1 Connections.

Measurement data is available at the DATA OUTPUT socket, D-J1, (Figure 2-3) on the rear panel of instruments with this option, for use by auxiliary data-handling equipment. This socket is a 50-pin Amphenol Type 57 socket which mates with a 50-pin Amphenol Type 57-30500 plug.

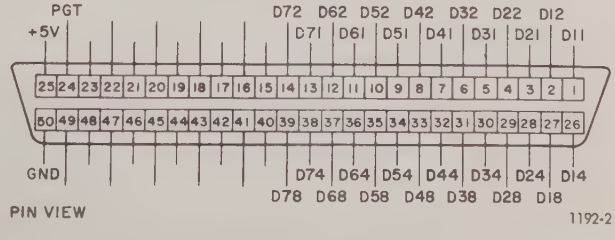

Figure 2-3 Data output socket signals.

Table 2-2
DATA SIGNALS

	7	6	5	4	3	2	1	
	0	1	7	3	7	8	4	
S0901 pin **Signal**	13 **D71**	11 **D61**	9 **D51**	7 **D41**	5 **D31**	3 **D21**	1 **D11**	1-BIT
S0901 pin **Signal**	14 **D72**	12 **D62**	10 **D52**	8 **D42**	6 **D32**	4 **D22**	2 **D12**	2-BIT
S0901 pin **Signal**	38 **D74**	36 **D64**	34 **D54**	32 **D44**	30 **D34**	28 **D24**	26 **D14**	4-BIT
S0901 pin **Signal**	39 **D78**	37 **D68**	35 **D58**	33 **D48**	31 **D38**	29 **D28**	27 **D18**	8-BIT

Table 2-3
DECIMAL-BCD EQUIVALENT

Decimal	1-2-4-8 BCD
0	0 0 0 0
1	1 0 0 0
2	0 1 0 0
3	1 1 0 0
4	0 0 1 0
5	1 0 1 0
6	0 1 1 0
7	1 1 1 0
8	0 0 0 1
9	1 0 0 1

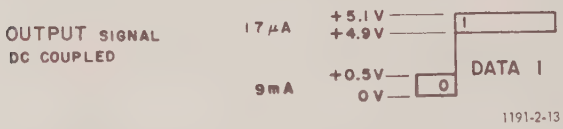

Figure 2-4 DTL levels from the data output socket for signals D11-D78 and PGT.

2.5.2 Data Signals.

Table 2-2 illustrates the data output signals from the various digits of the counter. Four 1-2-4-8 weighted BCD signals are available from each of the decades in the counter at standard DTL levels (data 0 ≈ ground with a 9-mA sink capability, data 1 ≈ +5 V behind 6 kΩ ±20%).

Table 2-3 lists the decimal-BCD equivalents and Figure 2-4 illustrates the dc-coupled output signal.

2.5.3 Print Command Signal.

Figure 2-5 shows the print command signal (PGT) available at D-J1, pin 24. The signal has standard DTL levels as shown in Figure 2-4 (DATA 0 ≅ ground with a 9-mA sink capability and DATA 1 ≅ +5 V behind 6 kΩ ±20%). The PGT signal is in the 1 state during the total display cycle and in the 0 state during the measurement cycle and reset cycle. The minimum time for maximum data transfer is 11 ms.

2.6 START-STOP CONNECTION.

The START and STOP input jacks are used to accept signals to originate and terminate measurements in the time interval mode. These jacks also provide a remote control for opening and closing the gate in the count mode.

When the START jack center terminal is connected to ground, the counter starts to count the interval clock in the time interval mode or the input supplied to the INPUT A jack in the count mode, until the STOP input center terminal is grounded. The START input must be removed before the STOP input is applied and the STOP input must be of less duration then the display time, which can be set from 10 ms to 10 s. If the STOP input is connected to ground permanently, the START input controls the counter and the time interval is measured on the INPUT A signal counted, as long as the START input is connected to ground.

2.7 LINE-VOLTAGE REGULATION.

The accuracy of measurements accomplished with precision electronic test equipment operated from ac line sources can often be seriously degraded by fluctuations in primary input power. Line-voltage variations as much as ±5% are commonly encountered, even in laboratory environments. Although most modern electronic instruments incorporate some degree of line-voltage regulation, consideration to possible power-source problems should be given for every instrumentation set-up. The use of line-voltage regulators between power lines and the test equipment is recommended as the only sure way to eliminate the effects on measurement data by low line voltage, transients, and other power phenomena.

The General Radio Type 1591 Variac® Automatic Voltage Regulator is a compact and inexpensive unit capable of holding ac power within ±0.2% accuracy for up to a rack full of solid-state instrumentation. The 1591 possesses a basic capacity of 1 kVA with no distortion of the input waveform. This rugged electromechanical regulator comes in bench or rack-mount configurations, both of which permit direct plug-in of measurement-instrument power cords.

Further details can be found in your GR catalog or in the GR ***Experimenter*** for October, 1967.

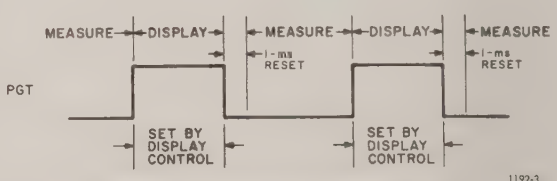

Figure 2-5 Print command signal (PGT).

Operation—Section 3

3.1 OPERATIONAL CHECKS 3-1
3.2 INPUT CONTROLS 3-5
3.3 FREQUENCY 3-8
3.4 PERIOD 3-8
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3.6 COUNT 3-9
3.7 TIME INTERVAL 3-12
3.8 RESET CONTROL 3-13
3.9 DISPLAY CONTROL 3-13
3.10 EXTERNAL TIME BASE 3-13
3.11 100kHz TEST SIGNAL 3-13

CAUTION

Do not exceed maximum signal ratings (INPUT A, 400-V dc coupling, 400 V ac pk coupling (except at 1:1 attenuation, 350 V ac pk); INPUT B, 400 V dc or 80 V ac pk.

3.1 OPERATIONAL CHECKS.

3.1.1 General.

This procedure can be used for incoming inspection, operator familiarization, or as a periodic check on the operation of the instrument. Table 3-1 lists the external-equipment needed for these checks.

3.1.2 Character Indication.

Set the controls as follows:

AC-DC . . . . . AC
INPUT ATTEN . . . . . 10:1 and 100:1 switches released
TRIGGER LEVEL . . . . . fully cw

Table 3-1
TEST EQUIPMENT

Name	Minimum Use Specification	Recommended Unit*
General-Purpose Oscillator	Generates 1-kHz sine wave, adjustable 0 to 5 V.	GR 1309 Oscillator (P/N 1309-9701)
Standard-Frequency Oscillator	Generates 100 kHz or 1 MHz with an amplitude >100 mV rms into 10 kΩ. Frequency must be $\geq \pm 10^{-5}$ of the 100-kHz or 1-MHz signal.	GR 1115 Standard-Frequency Oscillator (P/N 1115-9801)
Patch Cord	Double-plug-to-BNC adaptor cable to connect general-purpose oscillator to counter.	GR776-A Patch Cord (P/N 0776-9701)
Patch Cord	GR874®-to-BNC adaptor cable to connect standard-frequency oscillator to counter (2 required).	GR776-B Patch Cord (P/N 0776-9702)
Tee Connector	GR874 connectors in a tee configuration for joining two cables at the standard-frequency oscillator	GR874-T Tee (P/N 0874-9910)

*or equivalent.

Table 3-2
CHARACTER INDICATION*

Measurement Push Button	Gate Time — Periods or Ratios Averaged						TIME INTERVAL
	100 μs-1	1 ms-10	10 ms-10^2	100 ms-10^3	1 s-10^4	10 s-10^5	
FREQUENCY	0.00 MHz	0.000 MHz	0.0000 MHz	0.00 kHz	0.000 kHz	0.0 Hz	
PERIOD							
0.1 μs	0.0000 ms	0.00 μs	0.000 μs	0.0000 μs	0.00 ns	0.000 ns	0.0000 ms
1 μs	0 000 ms	0.0 μs	0.00 μs	0.000 μs	0.0 ns	0.00 ns	0.000 ms
10 μs	0.00 ms	μs	0.0 μs	0.00 μs	ns	0.0 ns	0.00 ms

*There are no decimal points for RATIO or COUNT measurements.

DISPLAY . . . . . .HOLD
POWER-OFF . . . . . .POWER
STORAGE ON-OFF (rear panel) . . . . .OFF (Depressed)

Depress the proper measurement button and check decimal-point location and symbol for all range settings as shown in Table 3-2 (digits may be other than zero). These decimal positions apply to all counter models.

3.1.3 Frequency Mode.

Set the controls as follows:

POWER OFF . . . . . .POWER
STORAGE ON-OFF . . . . . .OFF
100 kHz TEST . . . . . .Depressed
DISPLAY . . . . . .1 s
Range . . . . . .10 ms—10^2

Depress the FREQUENCY mode button. The counter will count the internal 100kHz TEST signal for 10 ms and then display it for 1 s. The visual display will be 000.1000 MHz (00.1000 MHz for 6-digit counter and 0.1000 MHz for 5-digit counter) ± 1 count.

3.1.4 Period Mode.

Set the controls as shown in paragraph 3.1.3. To check the three PERIOD positions, proceed as follows:

a. Depress the 0.1-μs push button. The counter will count the 10-MHz internal signal for 100 periods of the 100kHz TEST signal and display the results for 1 s. The visual register will read 0010.000 μs (010.000 μs for 6-digit counter and 10.000 μs for 5-digit counter).

b. Depress the 1-μs push button. The counter will count the internal 1-MHz signal for 100 periods of the internal 100kHz TEST signal. The visual register will display 00010.00 μs (0010.00 μs for 6-digit counter and 010.00 μs for 5-digit counter).

c. Depress the 10-μs push button. The counter will count the internal 100-kHz signal for 100 periods. The visual register will display 000010.0 μs (00010.0 μs for 6-digit counter and 0010.0 μs for 5-digit counter).

3.1.5 Count Mode.

Set the controls as shown in paragraph 3.1.3 except depress the COUNT START-STOP push button.

When the COUNT button is depressed the counter will start counting the internal 100-kHz signal and, when it is pressed again and released, the counter will stop counting and display an arbitrary number for 1 s before it is reset. If the START button is pushed before the display time is up, the counter will totalize, i.e., the new count will be added to the original count and the final answer will be the total of the two measurements.

A reset pulse is generated automatically when going from any measurement mode to the COUNT mode. This insures that the first measurement made in the COUNT mode is an accurate measurement.

3.1.6 Ratio Mode.

Set the controls as shown in paragraph 3.1.3 except set the range switch to the 100 ms—10^3 position.

Connect an external sine-wave signal (less than 10 MHz, greater than 100 mV rms) to the INPUT B connector on the rear panel and depress the RATIO push button on the front panel. The visual register will count for a time of 10^3 periods of the INPUT B signal. The 100kHz TEST signal is used instead of an external signal at INPUT A and it is the INPUT B signal divided by 100. The visual register will display 0000010 (000010 for 6-digit counter and 00010 for 5-digit counter). The measurement will be displayed for 1 s before being repeated. Under these measurement conditions, the INPUT B signal is the time base for the counter. (Before proceeding, disconnect the INPUT B signal).

Table 3-3
GATE-TIME CHECK

Gate Time	Visual Display		
	7 Digits	6 Digits	5 Digits
100 μs	00000.10 MHz	0000.10 MHz	000.10 MHz
1 ms	0000.100 MHz	000.100 MHz	00.100 MHz
10 ms	000.1000 MHz	00.1000 MHz	0.1000 MHz
100 ms	00100.00 kHz	0100.00 kHz	100.00 kHz
1 s	0100.000 kHz	100.000 kHz	*00.000 kHz
10 s	100.0000 Hz	*00.0000 Hz	*0.0000 Hz

*Indicates SPILL lamp is on at left-hand end of visual register. This means that the count overflowed the register.

Table 3-4
PERIODS-AVERAGED CHECK

Periods Averaged	Visual Display		
	7 Digit	6 Digit	5 Digit
1	0000.010 ms	000.010 ms	00.010 ms
10	000010.0 μs	00010.0 μs	0010.0 μs
10^2	00010.00 μs	0010.00 μs	010.00 μs
10^3	0010.000 μs	010.000 μs	10.000 μs
10^4	010000.0 ns	10000.0 ns	*0000.0 ns
10^5	10000.00 ns	*0000.00 ns	*000.00 ns

*Indicates SPILL lamp is on at left-hand end of visual register. This means that the count overflowed the register.

3.1.7 Range Switch.

Gate Time.

Recheck the counter controls and see that they are set as follows:

POWER-OFF . . . . . POWER
STORAGE ON-OFF . . . . . OFF
100kHz TEST . . . . . Depressed
FREQUENCY . . . . . Depressed
DISPLAY . . . . . 1 s

Set the range switch to the 100-μs position. The counter will count for 100-μs and display the results for 1 s in the visual registers. Table 3-3 lists the visual-register readings to be expected as the various GATE TIME settings of the range switch are checked.

Periods or Ratios Averaged.

NOTE

Be sure that the counter has stopped counting before the reading is checked.

To check these switches proceed as follows:

a. Set the controls as listed in paragraph 3.1.7 **Gate Time** except the PERIOD 1-μs push button should be depressed. The counter now counts the internal 1-MHz signal for the number of periods of the 100-kHz signal that is indicated by the setting of the range switch. Table 3-4 lists the visual-register readings for the settings of the range switch.

b. Depress the 0.1-μs push button. The visual register will read what is shown in Table 3-3, except each reading is moved 1 digit to the left. The spill lamp will come on in the 10^5 position.

c. Depress the 10-μs pushbutton. The visual register will read what is shown in Table 3-3, except each reading is moved one digit to the right.

3.1.8 Time Interval.

A time interval can be measured with a 0.1-, 1-, or 10-μs resolution between a start and stop pulse. Set the counter controls as follows:

POWER-OFF . . . . . POWER
100kHz TEST . . . . . Released
TIME INTERVAL 0.1μs
Range Switch . . . . . TIME INTERVAL
DISPLAY . . . . . 1 s

Connect the START input on the rear panel momentarily to ground and note that the counter counts at a 10-MHz rate (the seventh digit counts at a 0.1-s rate). Connect the STOP input momentarily to ground and note that the counting stops. The display will terminate after 1 s.

Repeat this procedure with the 1-μs TIME INTERVAL button depressed and note that the counter counts at a 1-MHz rate (the seventh digit counts at a 1-s rate).

Repeat the original procedure with the 10-μs button depressed and note that the counter counts at a 100-kHz rate (the sixth digit counts at a 1-s rate).

3.1.9 Display Control.

Set the controls as shown in paragraph 3.1.3 and press the FREQUENCY mode button. Vary the DISPLAY control from 10 s to 10 ms and note that the counter displays the measurement for approximately the indicated time.

NOTE

Numerals may appear to "pile up" at the shortest DISPLAY times.

Rotate the control to its farthest ccw position (HOLD) and note that the display time is infinite.

3.1.10 Reset.

The RESET push button resets all internal circuitry to zero and holds it at zero as long as it is depressed. Leave the controls as set for paragraph 3.1.9 and hold the RESET button depressed. Note that the visual register resets to zero

and stays at zero while the button is depressed. Release the button and note that a measurement is initiated.

3.1.11 Indicator Lamps.

Count. Press the COUNT pushbutton and see that the COUNT lamp on the left-hand end of the visual register turns on, indicating that the counter is counting. When the COUNT button is again depressed and released, the lamp will go out. This indicates that the main gate is shut off, terminating the count.

Spill. To check the spill lamp, set the controls as follows:

100kHz TEST . . . . . .Depressed
PERIOD 0.1 μs . . . . . .Depressed
DISPLAY . . . . . 1 s
Range Switch . . . . . 10^5

The SPILL lamp will glow as long as the register is displaying the measurement, indicating that the most significant figure has spilled over to the left.

3.1.12 Input A.

The INPUT A circuit takes the input waveform and translates each threshold crossing into a pulse for the counter to count. The TRIGGER LEVEL control determines the setting of the threshold at which the counter triggers. It can be varied from ccw to cw over a range of ±100 mV, ±1 V, ±10 V, or ±100 V, depending on the setting of the INPUT ATTEN buttons (1:1, 10:1, 100:1, or 1000:1, respectively).

Set the controls as follows:

FREQUENCY . . . . . .Depressed
DISPLAY . . . . . 1 s
Range Switch . . . . . 1 s
TRIGGER LEVEL . . . . . Centered
100kHz TEST . . . . . .Unlatched

To check the sensitivity levels, proceed as follows:

a. Apply an external 1-kHz sine-wave signal to the INPUT A connector. Adjust the 1-kHz signal level so that a 1-kHz reading is just obtained with the TRIGGER LEVEL centered.

b. Turn the TRIGGER LEVEL control fully cw and increase the signal level until the counter begins to count.

c. Depress the 10:1 INPUT ATTEN button and notice that the counter will count only at the most sensitive spot on the TRIGGER LEVEL control (near the + and - line) with the same input signal. By inserting the 10:1 attenuator the 10:1 change introduced by setting the TRIGGER LEVEL cw has been balanced off and the counter will trigger only at a point that is 10 times more sensitive, the center of the TRIGGER LEVEL control.

d. Set the TRIGGER LEVEL control to the full cw position and increase the input signal until the counter begins to count.

e. Depress the 10:1 button again to release it and depress the 100:1 button. Notice that the counter will again count only at its most sensitive position (near the + and - line).

f. Set the TRIGGER LEVEL to its full cw position and increase the input signal level until the counter begins to count.

g. Depress the 10:1 INPUT ATTEN button so total attenuation is 1000:1 and notice that the TRIGGER LEVEL must be set to its most sensitive position to obtain a reading.

3.1.13 Trigger Level.

To check the TRIGGER LEVEL control, set the controls as follows:

STORAGE . . . . . .Depressed (OFF)
TRIGGER LEVEL . . . . . cw
COUNT . . . . . .Depressed

Disconnect any signal from INPUT A and momentarily depress the RESET button. Turn the TRIGGER LEVEL in a ccw direction to its stop then back to the cw end. The right-hand digit in the visual register will display a 1. Repeat the ccw-cw swing of the TRIGGER LEVEL control and note that the numbers accumulate in the registers. This indicates that the TRIGGER LEVEL control is working properly.

3.1.14 Storage.

A push-button switch is provided on the rear panel to control the storage circuits. The advantage of using the storage mode is that no flicker is observed during the count cycle and, therefore, the last measurement remains displayed in the registers until the next measurement has been completed and is ready to be displayed. The counter employes a storage register for all the counting registers as well as the spill circuit.

To check the storage operation, depress 100kHz TEST and FREQUENCY, while leaving the STORAGE button unlatched. The display will remain constant, but the COUNT light will indicate the counter is counting.

If the storage feature is not needed, depress the push button to the OFF (IN) position. This operation has been checked in the modes previous to storage.

3.1.15 External Time Base.

The internal 10-MHz oscillator can be locked to an external 1-MHz or 100-kHz frequency source with a greater than 100 mV rms amplitude into 10 kΩ. A rear-panel push button is used to select the frequency to be used.

In order for the counter to lock on the external signal, the frequency must be within $\pm 10^{-5}$ of the 1-MHz or 100-kHz signal. To check whether the external signal meets these requirements, connect the signal to the INPUT A connector on the front panel and check that it reads 1000.000 kHz ±10 Hz or 100000.0 Hz ± 1 Hz.

If a 1-MHz external lock signal is used, set the EXT TIME BASE control on the rear panel to the out position and connect the 1-MHz signal to the INPUT B connector. To check that the signal has phase locked the counter, also connect the signal to the INPUT A connector, depress the FREQUENCY button and set the range switch to 10 s. The reading in the visual register should be 000000.0 with the SPILL lamp lit. Remove the INPUT B connection and the visual register should indicate the reading observed when the external frequency was originally measured at INPUT A. The only case that will not produce a change is if the external and internal oscillators are within $\pm 1 \times 10^{-7}$ of each other.

3.2 INPUT CONTROLS.

3.2.1 Characteristics.

Table 3-5 lists the input characteristics of the INPUT A and INPUT B channels.

3.2.2. Input A.

There are four front-panel controls that affect the INPUT A signal. Two of these controls are the INPUT ATTEN push buttons, the third is the AC-DC switch, and the fourth is the TRIGGER LEVEL control.

The two attenuator buttons are used to set the hysteresis of the counter (e.g., set the minimum sensitivity of the instrument). The best hysteresis value is one that is much larger than the largest noise signal expected at the input, but where the signal is adequately larger than the hysteresis to guarantee steady triggering. Under general operating conditions, the maximum attenuation available should be in use and then decreased until a steady reading is displayed in the visual register. A counter should rarely be used without any attenuation, except for very small input signals, since noise with a typical 5-mV rms level can trigger the counter.

The AC-DC switch determines the coupling between the INPUT A connector and the A Input circuit. Maximum and minimum values of frequency and amplitude are given in Table 3-5. As a general rule the counter will be operated in the AC position.

The TRIGGER LEVEL control is used to move the triggering point to a position on the waveform where the slope is steep and therefore often void of noise pulses. For the average waveform, the TRIGGER LEVEL should be set to the + and - line (zero crossing) since the steepest slope occurs at this point. When the input signal is a positive- or negative-going pulse, the trigger level must be moved away from the zero level, because damped oscillations often occur at the base line (zero level). The INPUT ATTEN push buttons control the range of the TRIGGER LEVEL control. The various ranges are listed as part of Table 3-5.

3.2.3 Input B.

The INPUT B connector on the rear panel is used only for RATIO measurements and as an input for the external time base input to lock the internal crystal oscillator. The trigger level is fixed for INPUT B at a slightly positive level and the hysteresis is fixed at less than 100 mV rms (1 V at frequencies less than 400 Hz).

3.2.4 General Settings.

The input controls can be set as follows for most measurements:

a. Connect the input signal to the INPUT A connector on the front panel. If a probe is used, insert the probe between the unknown signal and the INPUT A connector.

b. Set the AC-DC switch to the AC position. This switch can be set to the DC position for a very low frequency signal or when used with pulse inputs when the dc values are known.

c. Set the INPUT ATTEN push buttons for 100:1 or 10:1. The largest possible setting should be used, if the signal is adequate. When a large attenuation is used, the chance of erratic readings due to noise pulses is reduced.

d. Center the TRIGGER LEVEL control. If an ac signal is noisy at the zero crossing, rotate the TRIGGER LEVEL control in the positive or negative direction to obtain a stable reading. When the input signal contains a dc component, set the TRIGGER LEVEL cw or ccw to obtain a measurement (paragraph 3.2.5).

3.2.5 Special Settings.

Table 3-6 shows some examples of input signals that require special adjustments of the input controls. These settings are variations of the general settings given in paragraph 3.2.4. The voltages shown are at the input to the triggering circuits; after attenuation by the probe (if used) and the INPUT ATTEN switches.

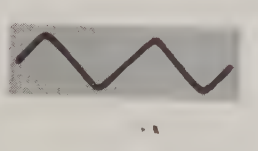
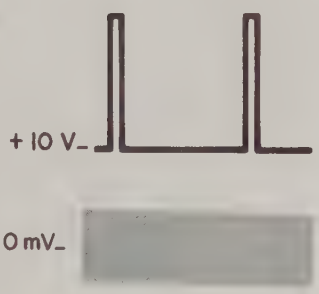
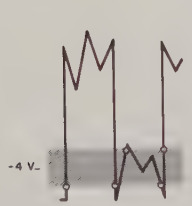
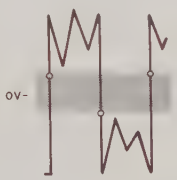
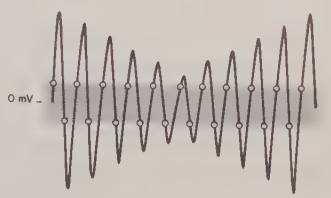
Table 3-5
INPUT CHARACTERISTICS*

Input	Attenuator	Without Probe		With Probe		Trigger Level Range	
		Minimum	Maximum	Minimum	Maximum**	Without Probe	With Probe
A	1:1	10 mV rms, 30 mV pk-pk to 20 MHz. 20 mV rms, 60 mV pk-pk to 32 MHz.	400 V dc or 350 V ac pk	100 mV rms, 300 mV pk-pk to 20 MHz. 200 mV rms, 600 mV pk-pk to 32 MHz.	600 V dc or ac pk-pk	±100 mV	±1 V
	10:1	100 mV rms, 300 mV pk-pk to 20 MHz, 200 mV rms, 600 mV pk-pk to 32 MHz.	400 V dc or ac pk.	1 V rms, 3 V pk-pk to 20 MHz, 2 V rms, 6 V pk-pk to 32 MHz.	600 V dc or ac pk-pk	±1 V	±10 V
	100:1	1 V rms, 3 V pk-pk to 20 MHz. 2 V rms, 6 V pk-pk to 32 MHz.	400 V dc or ac pk.	10 V rms, 30 V pk-pk to 20 MHz. 20 V rms, 60 V pk-pk to 32 MHz.	600 V dc or ac pk-pk	±10 V	±100 V
	1000:1	10 V rms, 3 V pk-pk to 20 MHz. 20 V rms, 60 V pk-pk to 32 MHz.	400 V dc or ac pk	100 V rms, 300 V pk-pk to 20 MHz. 200 V rms, 600 V pk-pk to 32 MHz.	600 V dc or ac pk-pk	±100 V	±1000 V (Limited by probe rating.)
B	None	100 mV rms, 300 mV pk-pk above 400 Hz. 1 V rms, 3 V pk-pk below 400 Hz.	400 V dc, 80 V ac pk.	No Probe	No Probe	Fixed Position Trigger Level	No Probe

*Frequency, INPUT A: dc coupled, dc to 32 MHz; ac coupled, 3 Hz to 32 MHz.
Frequency, .INPUT B: ac coupled only, 50 Hz to 10 MHz.
Impedance, INPUT A: 1 MΩ shunted with 27 pF, without probe; 10 MΩ shunted with 7 pF, with probe.
Impedance, INPUT B: 10 kΩ shunted with 20 pF, without probe.
**Less over 4.5 MHz: 500 V at 5.5 MHz, 400 V at 7 MHz, 300 V at 9 MHz, 200 V at 14 MHz, and 100 V at 25 MHz.

Table 3-6

SPECIAL INPUT-SIGNAL CONDITIONS

Problem	Solution
Insufficient signal. Signal level is less than hysteresis; no triggering occurs. 	Signal level increased or attenuation decreased (INPUT ATTEN set from 1000 or 100 or 10 to 1); proper triggering occurs.
Dc component. Signal contains positive dc component; with TRIGGER LEVEL control centered, no trigger occurs.	Trigger level set to same value as dc component of signal (TRIGGER LEVEL control turned cw, if dc component had been negative, TRIGGER LEVEL control would have been turned ccw); proper triggering occurs.
Excessive dc component, low duty ratio. Signal contains a large positive dc component; no triggering occurs. 	Ac coupling used to eliminate dc component; low duty ratio prevents triggering. TRIGGER LEVEL control turned cw if pulses had been negative, TRIGGER LEVEL control would have been turned ccw; proper triggering occurs.
Noise. Noise peaks exceed hysteresis; erratic and erroneous trigger occurs. 	Trigger level set out of noise range; proper triggering occurs.  Hysteresis increased by going to the next larger attenuation or signal level decreased so that noise peaks do not exceed hysteresis; proper triggering occurs.
Am signal. Amplitude modulation reduces signal below hysteresis; counts are missed.	Signal level increased or attenuation decreased; proper triggering occurs. 

3.3 FREQUENCY.

3.3.1 General.

The 1192 Counter will measure frequencies up to 32 MHz with a resolution of 0.1 Hz (Figure 3-1). The frequency mode is selected by depressing the FREQUENCY push button on the front panel of the counter. Counting

Figure 3-1 Sine-wave signal for frequency measurement.

times are set by the GATE TIME positions on the range switch. This switch also automatically selects the decimal-point position and the measurement units. The display time is set by the DISPLAY control.

The resolution of a measurement is often an important measurement consideration. The short gate times available in the 1192 should be used for low-resolution or high-frequency measurements and the longer gate times for high resolution or low-frequency measurements. A measurement made with a 5- or 6-digit counter can be made to have the same resolution as a 7-digit counter by making the measurement twice, first measuring the most significant digits and then the least significant digits. Table 3-7 shows the resolution available from the 1192 Counter for the GATE TIME positions.

3.3.2 Settings.

To make a frequency measurement, proceed as follows:

a. Set the POWER - OFF switch to POWER.

b. Depress the front-panel FREQUENCY push button.

c. Set the range switch to the desired GATE TIME position.

d. Set the DISPLAY control to the desired position.

e. Connect the input signal to the INPUT A connector.

f. Set the INPUT ATTEN push buttons, the AC-DC switch, and the TRIGGER LEVEL control to the proper positions, as outlined in paragraph 3.2.2.

g. Read the measured value of the input signal from the visual register.

3.4 PERIOD.

3.4.1 General.

If the frequency of the input signal is low enough that adequate resolution cannot be obtained with the gate times available, or the measurement time is longer than desired for a frequency measurement, use the period mode. There are three PERIOD-mode push buttons; 0.1μs, 1 μs, and 10μs. The 0.1-μs PERIOD button is depressed for maximum resolution measurements and for period measurements of high-frequency signals. When this position is used, the 10-MHz internal signal is counted and the length of the count gate is determined by the INPUT A signal.

The 1-μs PERIOD position counts the 1-MHz internal signal and is used for medium resolution and frequency measurements.

The 10-μs PERIOD position counts the 100-kHz internal signal and is used for low resolution and frequency measurements. This position should also be used to prevent spillover in a 5- or 6-digit counter when the signal is averaged over several periods.

The range switch PERIODS AND RATIOS AVERAGED positions determine the number of periods for which the gate is open (Figure 3-2). The longer the gate remains open the less the noise on the input signal will affect the final

Table 3-7
FREQUENCY MEASUREMENT

Function	Gate Time					
	100 μs	1 ms	10 ms	100 ms	1 s	10 s
RESOLUTION	10 kHz	1 kHz	100 Hz	10 Hz	1 Hz	0.1 Hz
SPILL (maximum before overflow)						
5-DIGIT COUNTER	No Spill	No Spill	10 MHz	1 MHz	100 kHz	10 kHz
6-DIGIT COUNTER	No Spill	No Spill	No Spill	10 MHz	1 MHz	100 kHz
7-DIGIT COUNTER	No Spill	No Spill	No Spill	No Spill	10 MHz	1 MHz
	± (1 count + time-base accuracy)					

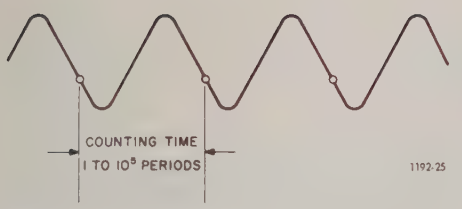


Figure 3-2 Sine-wave signal for period measurement.

measurement, since the noise gets reduced through the averaging process. No matter how many periods are averaged, the final answer displayed in the visual register will be the time for one period, including the decimal point and measurement units. Table 3-8 shows the measurement resolution possible and also the maximum periods that can be measured with 5-, 6-, and 7-digit counter models.

3.4.2 Settings.

To make a period measurement, proceed as follows:

a. Set the POWER-OFF switch to POWER.

b. Depress front-panel PERIOD AND TIME INTERVAL push button desired.

c. Set the range switch to the highest number of PERIODS OR RATIOS AVERAGED that will give a reasonable measurement time and not produce any spillover.

d. Set the DISPLAY control to the desired position.

e. Connect the input signal to the INPUT A connector.

f. Set the INPUT ATTEN push buttons, the AC-DC switch, and the TRIGGER LEVEL control to the proper positions as outlined in paragraph 3.2.2.

g. Read the measured value of the input-signal period in the visual register. The reading displayed in the visual register is the value of one period, regardless of how many periods were averaged.

3.5 RATIO.

3.5.1 General

A ratio measurement is made between two input signals, one connected to the front-panel INPUT A connector and the other connected to the rear-panel INPUT B connector. The pulses that are counted are derived from the INPUT A signal and the counting time is established by the period of the INPUT B signal. The range switch selects the number of ratios to be averaged from 1 to 10^5 (Figure 3-3).

The lower frequency signal is normally applied to the INPUT B connector and the higher to INPUT A. The

Table 3-8
PERIOD MEASUREMENT

Function	Periods Averaged					
	1	10	10^2	10^3	10^4	10^5
RESOLUTION* ±(1 count + trigger error + time-base accuracy)						
0.1μs	0.1μs	10ns	1ns	0.1ns	10ps	1ps
1μs	1μs	0.1μs	10ns	1ns	0.1ns	10ps
10μs	10μs	1μs	0.1μs	10ns	1ns	0.1ns
7-DIGIT SPILL**,†						
0.1μs	1s	0.1s	10ms	1ms	0.1ms	10μs
1μs	10s	1s	0.1s	10ms	1ms	0.1ms
10μs	100s	10s	1s	0.1s	10ms	1ms
6-DIGIT SPILL**,†						
0.1μs	0.1s	10ms	1ms	0.1ms	10μs	1μs
1μs	1s	0.1s	10ms	1ms	0.1ms	10μs
10μs	10s	1s	0.1s	10ms	1ms	0.1ms
5-DIGIT SPILL**,†						
0.1μs	10ms	1ms	0.1ms	10μs	1μs	0.1μs
1μs	0.1s	10ms	1ms	0.1ms	10μs	1μs
10μs	1s	0.1s	10ms	1ms	0.1ms	10μs

*Resolution averaged for one period.

**Values indicate time for 1 period at which spill will occur. For example, if a seven-digit counter counts for one period with the 0.1-μs time base, the visual register will spill over (SPILL) if the input signal has a period greater than 1 s.

†If the most significant figure of a period is known, the period measurement can be extended by a factor of ten if the known most significant figure is allowed to spill over. If two figures are known, a factor of one hundred is possible, etc.

Table 3-9
RATIO MEASUREMENT

Function	Ratios Averaged					
	1	10	10^2	10^3	10^4	10^5
RESOLUTION	Determined by the input A signal.					
ACCURACY	±(1 input A count + input B trigger error)					
MAXIMUM RATIO WITHOUT SPILL						
7-DIGIT COUNTER	10^7:1	10^6:1	10^5:1	10^4:1	10^3:1	10^2:1
6-DIGIT COUNTER	10^6:1	10^5:1	10^4:1	10^3:1	10^2:1	10:1
5-DIGIT COUNTER	10^5:1	10^4:1	10^3:1	10^2:1	10:1	1:1

reading of the visual register is the ratio A/B times the number of ratios averaged.

The resolution of a RATIO measurement will increase as the number of ratios averaged is increased, however, remember to divide the answer read in the visual register by the factor of ten that the range switch is set to, in order to obtain the correct ratio between the signals.

If the lower signal is less than 50 Hz, the signals can be interchanged and, by use of the range switch, a ratio reading can be obtained. For example, if a 30-Hz signal is connected to INPUT A and a 1000-Hz signal is connected to INPUT B, the A/B ratio would be 0.03. Since there are no decimal points displayed in the RATIO mode, the range switch must be moved to the 10^2 position to obtain a reading of 3 in the visual register. Therefore, the ratio of the signals would be 3 divided by 10^2 or 0.03, as stated before.

3.5.2 Settings.

To make a RATIO measurement, proceed as follows:

a. Set the POWER-OFF switch to POWER.

b. Depress the front-panel RATIO A/B push button.

c. Set the range switch to the number of ratios averaged desired (Table 3-9).

d. Set the DISPLAY control to the desired position.

e. Connect signal A to the INPUT A connector on the front panel and signal B to the rear-panel INPUT B connector.

f. Set the INPUT ATTEN push buttons, the AC-DC switch, and the TRIGGER LEVEL control to the proper positions as outlined in paragraph 3.2.2.

g. Read the ratio between the two signals from the visual register. Remember that if more than one ratio is averaged the reading in the visual register must be divided by the number of ratios averaged to obtain the correct ratio.

3.6 COUNT.

3.6.1 General.

Signals fed into the INPUT A connector can be counted up to 32 x 10^6 events/second for an arbitrary length of time. This time period can be set manually by the front-panel COUNT push button, remotely by applying start and stop pulses, or remotely by a gate.

In the general case, in which an event is counted over one interval only, the DISPLAY control functions in its usual manner, i.e., the visual register will reset to zero after the display time has elapsed. However, if it is desired to totalize the count, i.e., add one interval to the next, the DISPLAY control should be set to the HOLD position. The effect of a totalized count will also occur if the DISPLAY control is set to a longer time than the interval allowed before a second measurement is initiated.

3.6.2 Manual Settings.

To make a count measurement using the manual COUNT push button, proceed as follows:

a. Set the POWER-OFF switch to POWER.

b. Set the INPUT ATTEN push buttons, the AC-DC switch, and the TRIGGER LEVEL control to the proper positions as outlined in paragraph 3.2.2.

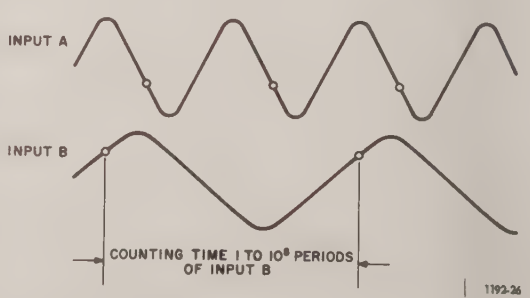


Figure 3-3 Input signals for a ratio measurement.

c. Connect the input signal to INPUT A.

d. Set the DISPLAY control for the display time desired. If totalization is desired, set the DISPLAY control to HOLD.

e. Depress the COUNT push button and the counter will start counting the signal connected to INPUT A. If the counter was previously used in any other measurement mode, a reset pulse will be generated when the COUNT button is depressed, so that the count will start from zero.

f. To terminate the count, depress the COUNT button again and it will release.

NOTE

When the COUNT button is depressed, no other measurement-mode button will stay depressed. Therefore, before going to any other measurement mode, release the COUNT button and then depress the desired measurement-mode button.

3.6.3 Stop and Start Settings.

To make a count measurement using the START and STOP connectors on the rear panel, proceed as follows:

a. Set the POWER-OFF switch to POWER.

b. Set the INPUT ATTEN push buttons, the AC-DC switch, and the TRIGGER LEVEL control to the proper positions as outlined in paragraph 3.2.2.

c. Depress the COUNT push button.

d. Connect the input signal to the INPUT A connector. Do not connect any signal to the INPUT B connector.

e. Connect a signal to the START connector on the rear of the counter. Refer to the specifications page for the signal values. Once this signal is applied, the counter will start counting.

f. Connect a signal to the STOP connector on the rear of the counter. Refer to the specifications page for the signal values. Once this signal is applied to the counter the counter will stop counting, assuming that the start input has been terminated.

g. Set the DISPLAY control for the display time desired. If totalization is desired, set the DISPLAY control to HOLD; also, if the display time is longer than the intervals between counts, the counter will totalize.

NOTE

If the counter is used in the storage mode, the width of the stop pulse must be less than the display time, otherwise the counter will operate as in the non-storage mode.

3.6.4 Remote Gate Settings.

To make a count measurement using a remote gate as a control, proceed as follows:

a. Set the POWER-OFF switch to POWER.

Figure 3-4 Time-interval measurement start and stop pulses.

Figure 3-5 Pulse-duration measurement triggering points.

b. Set the INPUT ATTEN push buttons, the AC-DC switch, and the TRIGGER LEVEL control to the proper positions as outlined in paragraph 3.2.2.

c. Depress the COUNT push button.

d. Connect the input signal to the INPUT A connector. Do not connect any signal to the INPUT B connector.

e. Depress the STORAGE push button to its non-storage position on the rear of the counter.

f. Connect the STOP input on the rear panel to ground.

g. Connect the remote gate to the START input on the rear panel. Refer to the specifications page for signal levels. As long as the remote gate is in its low state, the counter is counting the signal at INPUT A. When the remote gate goes to its high state, the counter will stop and display the measurement.

h. Set the DISPLAY control for the display time desired. If totalization is desired, set the DISPLAY control to HOLD. Also, if the display time is longer than the intervals between counts, the counter will totalize.

3.7 TIME INTERVAL.

3.7.1 General.

The time interval between two signals, or the duration of a signal, can be measured in the TIME-INTERVAL mode down to a resolution of 100 ns. Between the start and stop

Table 3-10

TIME-INTERVAL MEASUREMENT*

Function	Time Base 0.1μs	1μs	10μs
MAXIMUM INTERVAL BEFORE SPILL			
7-DIGIT COUNTER	1s	10s	100s
6-DIGIT COUNTER	0.1s	1s	10s
5-DIGIT COUNTER	0.01s	0.1s	1s

*The resolution for each counter is the value of the timebase (0.1 μs, 1μs, or 10μs) ±(1 count + trigger error + timebase accuracy).

pulses, or within the duration of the signal being measured, the counter counts its internal clock (Figures 3-4 and 3-5). The internal clock is selected by the front-panel TIME INTERVAL pushbuttons. The 0.1-μs position counts the 10-MHz signal, the 1-μs position counts the 1-MHz signal, and the 10-μs position counts the 100-kHz signal. Table 3-10 states the resolution and spill time for each counter.

3.7.2 Start and Stop Pulse Settings.

To make a time-interval measurement between two pulses, proceed as follows:

a. Set the POWER-OFF switch to POWER.

b. Depress the PERIOD OR TIME INTERVAL push button desired. Use the 0.1-μs button for maximum resolution and short intervals, the 1-μs button for medium resolution and longer intervals, and the 10-μs button for the least resolution and longest intervals.

c. Set the range switch to TIME INTERVAL.

d. Connect the start pulse to the rear-panel START connector. Refer to the specifications page for signal levels.

e. Connect the stop pulse to the rear-panel STOP connector. Refer to the specifications page for signal levels.

NOTE

The start pulse must be terminated before the stop pulse is applied. If storage operation is used, the stop pulse must be less than the display time (otherwise the storage mode operates like the non-storage mode).

f. Set the DISPLAY control to the desired position. If the storage mode is to be used, set the DISPLAY control for a longer time than the duration of the stop pulse. If the DISPLAY control is set to HOLD, or to a longer display time than the time difference between the stop pulse terminating one measurement and the start pulse initiating the next measurement, the counter will totalize all the time-interval measurements.

3.7.3 Pulse-Duration Settings.

To measure the duration of a pulse, proceed as follows:

a. Set the POWER-OFF switch to POWER.

b. Depress the PERIOR OR TIME INTERVAL button desired (paragraph 3.7.2, step b).

c. Set the range switch to TIME INTERVAL.

d. Connect the rear-panel STOP connector to ground.

e. Connect the pulse whose time duration is to be measured to the rear-panel START connector. Refer to the specifications page for signal levels.

f. Set the rear-panel STORAGE button to the OFF position.

g. Set the DISPLAY control for the desired length of display time.

NOTE

If the DISPLAY control is set to HOLD or to a longer display time than the time between the end of one pulse and the beginning of the next, the counter will totalize all the time durations measured.

3.8 RESET CONTROL.

The RESET push button sets all the internal circuits in the counter to zero and holds them in their reset position until the button is released. This button is also used to initiate new measurements, when the display time is set for infinity (HOLD position).

3.9 DISPLAY CONTROL.

The DISPLAY control determines the time the counter displays a measurement before the next measurement is initiated. The display time can be continuously adjusted from 10 ms to greater than 10 s (typically 12 s).

The counter also has an infinite-display-time position called HOLD. In this position the counter displays the last measurement indefinitely or until the RESET button is depressed.

A storage register is employed in the counter that stores and displays the results of one measurement while another measurement is being taken. The total display time in this mode is the sum of the display time as set by the DISPLAY control and the gate length, or the number of periods, as set by the range switch.

3.10 EXTERNAL TIME BASE.

The 1192 Counter can be phase locked to an external signal. Paragraph 3.1.15 outlines the procedure for obtaining a lock to an external signal.

3.11 100kHz TEST SIGNAL.

The 100kHz TEST signal is used to check that the internal logic circuitry is operating properly. In the FREQUENCY, PERIOD and COUNT modes, the 100-kHz signal is used instead of the INPUT A signal. In the RATIO mode, the test signal is the INPUT B signal divided by 100. This signal was used as the primary test signal in the checks presented in paragraph 3.1. The signal can be measured at any time by setting the controls as if making a measurement of a signal at the INPUT A connector. For example, to make a frequency measurement of the signal, proceed as follows:

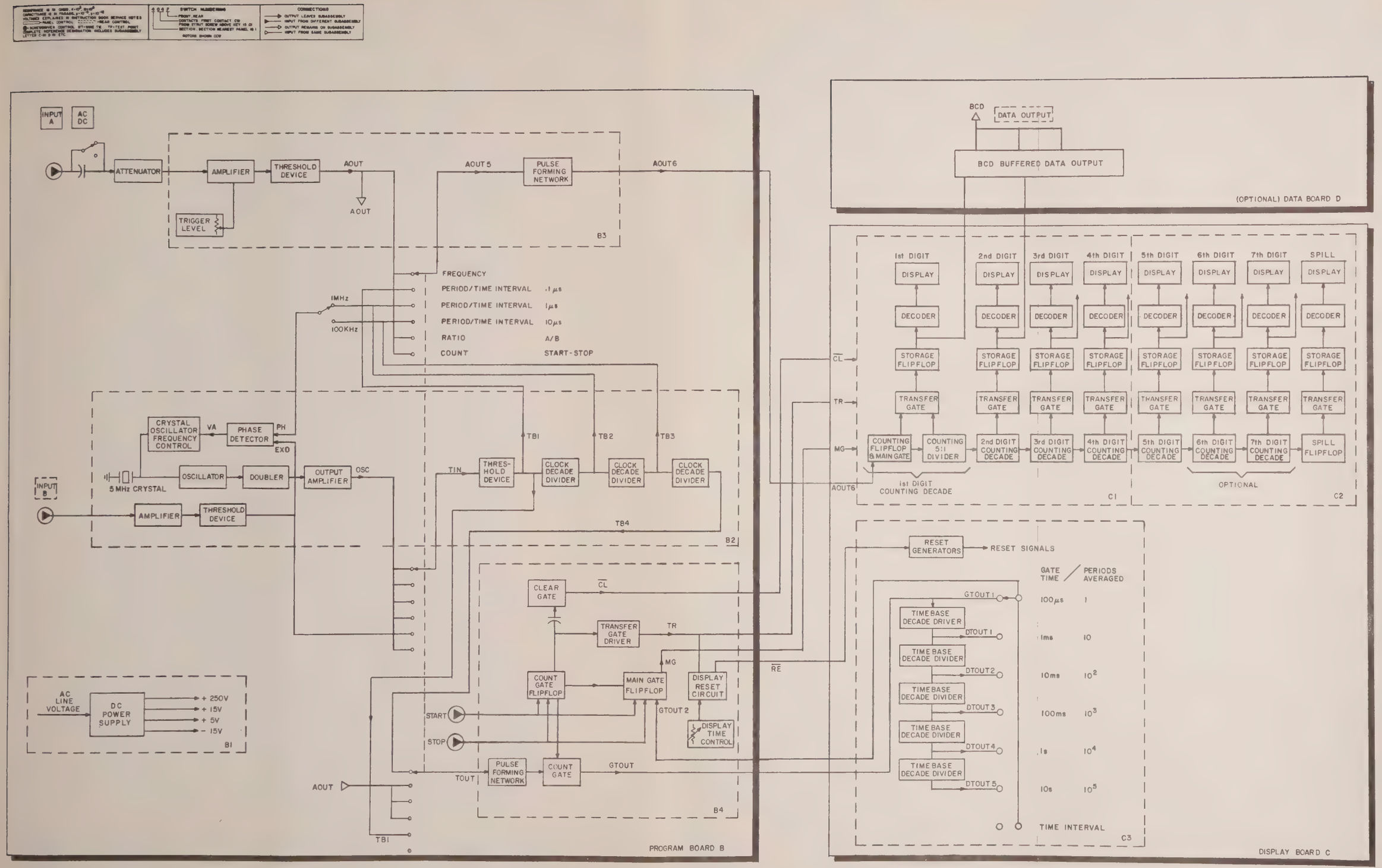
a. Set the POWER-OFF switch to POWER.

b. Depress the FREQUENCY and 100kHz TEST push buttons.

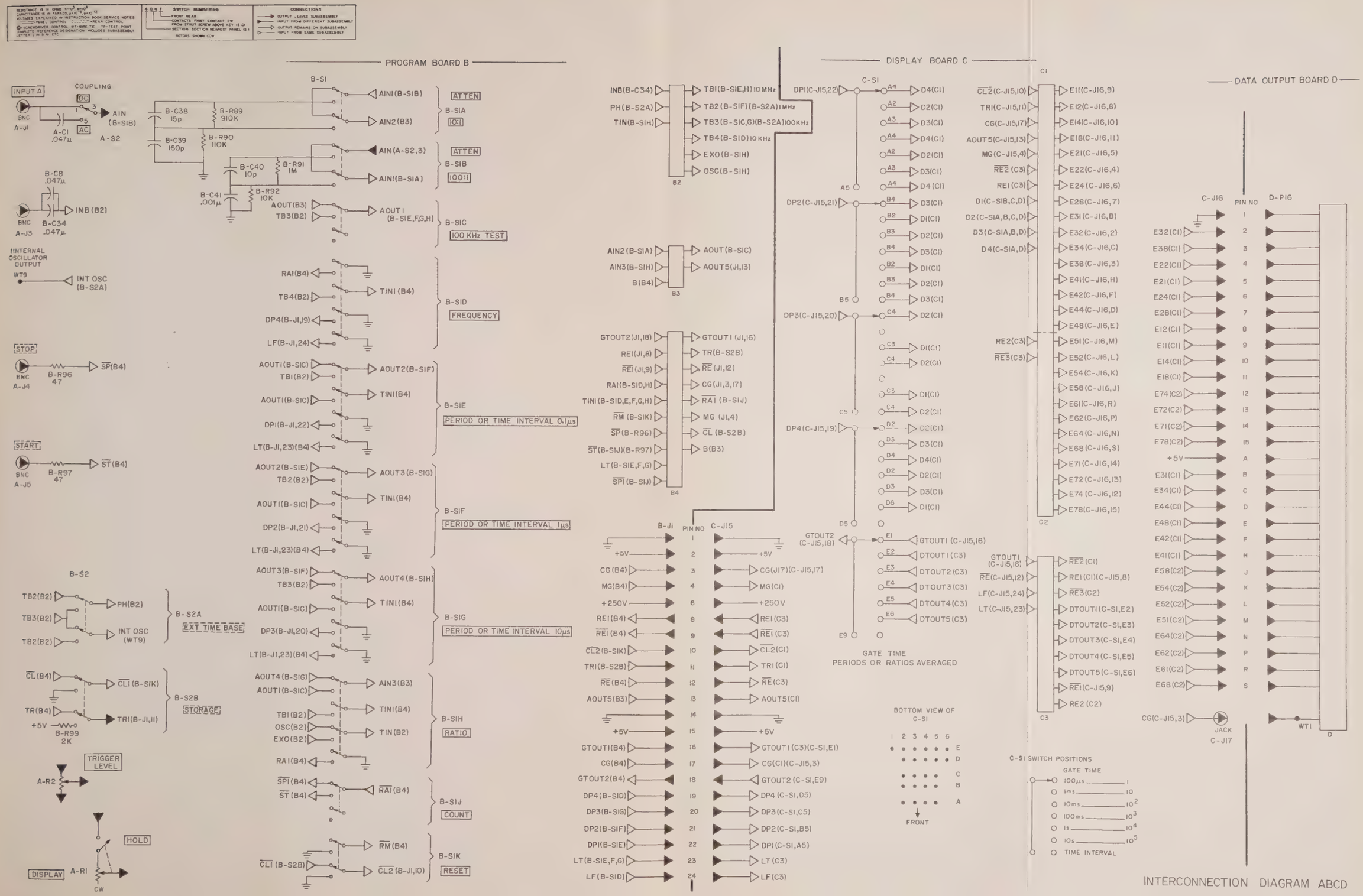
c. Set the DISPLAY control to the desired length of time.

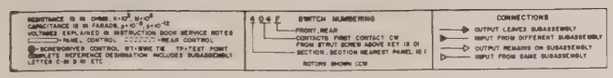
d. Set the range switch to the GATE TIME desired.

e. Read the 100-kHz value from the visual register. The SPILL lamp will light if the GATE TIME is set to 1 s or 10 s for a 5-digit counter and if set to 10 s for a 6-digit counter.



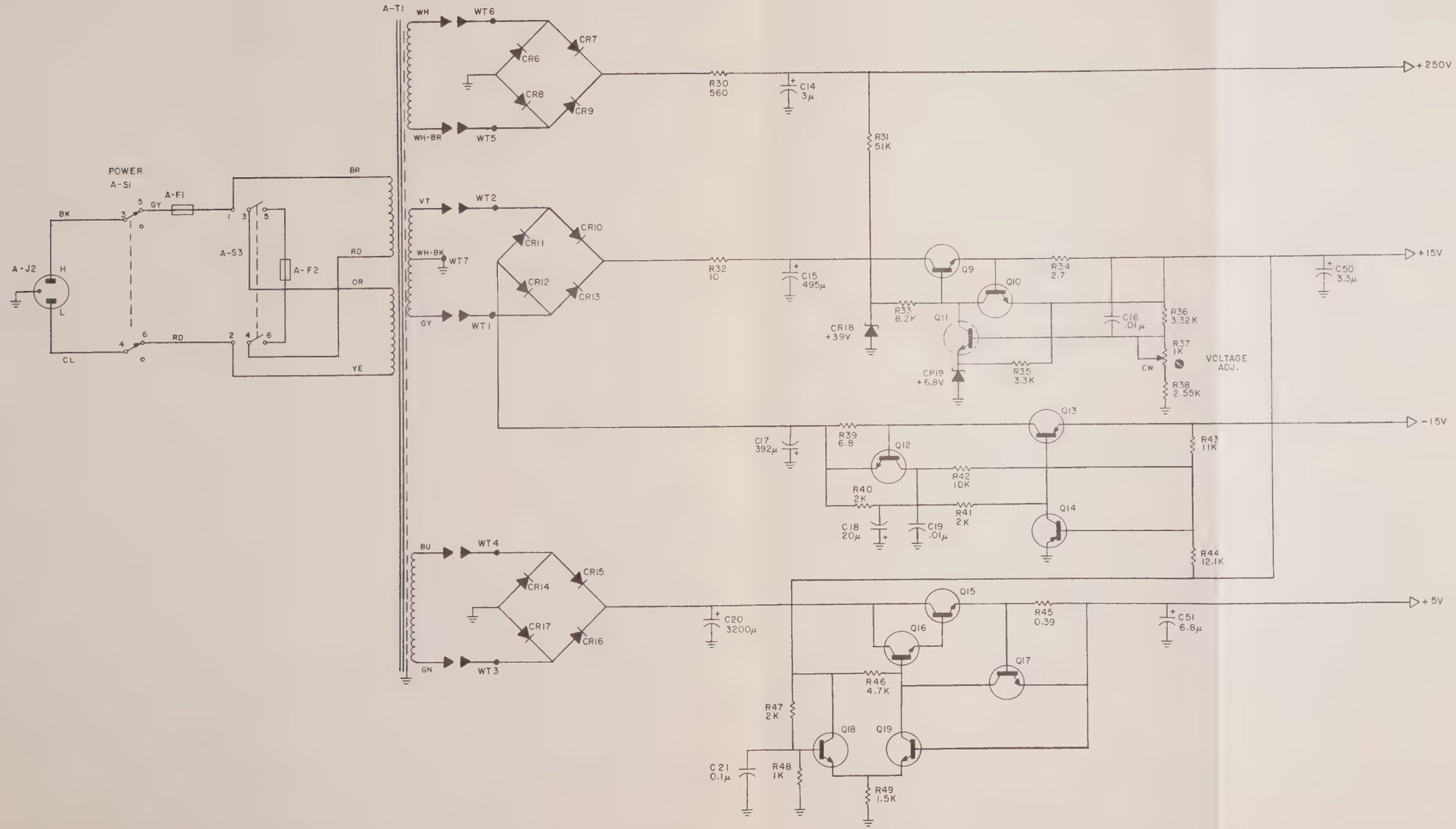
1192 BLOCK DIAGRAM


PROGRAM BOARD B
DISPLAY BOARD C
DATA OUTPUT BOARD D
INPUT A
COUPLING
DC
AC
BNC A-J1
A-C1 .047µ
A-S2
AIN (B-SIB)
B-SI
AINI(B-SIB)
AIN2(B3)
ATTEN
B-SIA
10:1
B-C38 15p
B-R89 910K
B-C39 160p
B-R90 110K
B-C40 10p
B-R91 1M
B-C41 .001µ
B-R92 10K
AIN(A-S2,3)
AINI(B-SIA)
ATTEN
B-SIB
100:1
B-C8 .047µ
INB (B2)
BNC A-J3
B-C34 .047µ
AOUT(B3)
TB3(B2)
AOUT I (B-SIE,F,G,H)
B-SIC
100 KHz TEST
INTERNAL OSCILLATOR OUTPUT
WT9
INT OSC (B-S2A)
RAI(B4)
TB4(B2)
DP4(B-JI,19)
LF(B-JI,24)
TINI (B4)
B-SID
FREQUENCY
STOP
BNC A-J4
B-R96 47
SP(B4)
AOUTI(B-SIC)
TBI(B2)
AOUTI(B-SIC)
DPI(B-JI,22)
LT(B-JI,23)(B4)
AOUT2(B-SIF)
TINI(B4)
B-SIE
PERIOD OR TIME INTERVAL 0.1µs
START
BNC A-J5
B-R97 47
ST(B4)
AOUT2(B-SIE)
TB2(B2)
AOUTI(B-SIC)
DP2(B-JI,21)
LT(B-JI,23)(B4)
AOUT3(B-SIG)
TINI(B4)
B-SIF
PERIOD OR TIME INTERVAL 1µs
B-S2
TB2(B2)
TB3(B2)
TB2(B2)
PH(B2)
INT OSC (WT9)
B-S2A
EXT TIME BASE
AOUT3(B-SIF)
TB3(B2)
AOUTI(B-SIC)
DP3(B-JI,20)
LT(B-JI,23)(B4)
AOUT4(B-SIH)
TINI(B4)
B-SIG
PERIOD OR TIME INTERVAL 10µs
CL(B4)
TR(B4)
+5V
B-R99 2K
CLI(B-SIK)
TRI(B-JI,11)
B-S2B
STORAGE
AOUT4(B-SIG)
AOUTI(B-SIC)
TBI(B2)
OSC(B2)
EXO(B2)
RAI(B4)
AIN3(B3)
TINI(B4)
TIN(B2)
B-SIH
RATIO
TRIGGER LEVEL
A-R2
HOLD
DISPLAY
A-RI
CW
SPI(B4)
ST(B4)
RAI(B4)
B-SIJ
COUNT
RM(B4)
CLI(B-S2B)
CL2(B-JI,10)
B-SIK
RESET
INB(B-C34)
PH(B-S2A)
TIN(B-SIH)
TBI(B-SIE,H) 10 MHz
TB2(B-SIF)(B-S2A) 1 MHz
TB3(B-SIC,G)(B-S2A) 100 KHz
TB4(B-SID) 10 KHz
EXO(B-SIH)
OSC(B-SIH)
B2
AIN2(B-SIA)
AIN3(B-SIH)
B(B4)
AOUT(B-SIC)
AOUT5(JI,13)
B3
GTOUT2(JI,18)
REI(JI,8)
REI(JI,9)
RAI(B-SID,H)
TINI(B-SID,E,F,G,H)
RM(B-SIK)
SP(B-R96)
ST(B-SIJ)(B-R97)
LT(B-SIE,F,G)
SPI(B-SIJ)
GTOUT I (JI,16)
TR(B-S2B)
RE(JI,12)
CG(JI,3,17)
RAI(B-SIJ)
MG(JI,4)
CL(B-S2B)
B(B3)
B4
B-JI
PIN NO
C-JI5
+5V
CG(B4)
MG(B4)
+250V
REI(B4)
REI(B4)
CL2(B-SIK)
TRI(B-S2B)
RE(B4)
AOUT5(B3)
+5V
GTOUTI(B4)
CG(B4)
GTOUT2(B4)
DP4(B-SID)
DP3(B-SIG)
DP2(B-SIF)
DPI(B-SIE)
LT(B-SIE,F,G)
LF(B-SID)
CG(JI7)(C-JI5,17)
MG(CI)
+250V
REI(C3)
REI(C3)
CL2(CI)
TRI(CI)
RE(C3)
AOUT5(CI)
+5V
GTOUTI (C3)(C-SI,EI)
CG(CI)(C-JI5,3)
GTOUT2 (C-SI,E9)
DP4 (C-SI,D5)
DP3(C-SI,C5)
DP2(C-SI,B5)
DPI(C-SI,A5)
LT (C3)
LF(C3)
DPI(C-JI5,22)
C-SI
A5
DP2(C-JI5,21)
B5
DP3(C-JI5,20)
C5
DP4(C-JI5,19)
D5
GTOUT2 (C-JI5,18)
E9
D4(CI)
D2(CI)
D3(CI)
D4(CI)
D2(CI)
D3(CI)
D4(CI)
D3(CI)
DI(CI)
D2(CI)
D3(CI)
D4(CI)
D2(CI)
DI(CI)
D2(CI)
D3(CI)
D4(CI)
D2(CI)
D3(CI)
D6
DI(CI)
GTOUTI (C-JI5,16)
DTOUTI (C3)
DTOUT2(C3)
DTOUT3(C3)
DTOUT4(C3)
DTOUT5(C3)
GATE TIME
PERIODS OR RATIOS AVERAGED
BOTTOM VIEW OF C-SI
1 2 3 4 5 6
E
D
C
B
A
FRONT
CL2(C-JI5,10)
TRI(C-JI5,11)
CG(C-JI5,17)
AOUT5(C-JI5,13)
MG(C-JI5,4)
RE2(C3)
REI(C3)
DI(C-SIB,C,D)
D2(C-SIA,B,C,D)
D3(C-SIA,B,D)
D4(C-SIA,D)
RE2(C3)
RE3(C3)
C1
C2
E11(C-JI6,9)
E12(C-JI6,8)
E14(C-JI6,10)
E18(C-JI6,11)
E21(C-JI6,5)
E22(C-JI6,4)
E24(C-JI6,6)
E28(C-JI6,7)
E31(C-JI6,8)
E32(C-JI6,2)
E34(C-JI6,C)
E38(C-JI6,3)
E41(C-JI6,H)
E42(C-JI6,F)
E44(C-JI6,D)
E48(C-JI6,E)
E51(C-JI6,M)
E52(C-JI6,L)
E54(C-JI6,K)
E58(C-JI6,J)
E61(C-JI6,R)
E62(C-JI6,P)
E64(C-JI6,N)
E68(C-JI6,S)
E71(C-JI6,I4)
E72(C-JI6,I3)
E74(C-JI6,I2)
E78(C-JI6,I5)
GTOUTI (C-JI5,16)
RE(C-JI5,12)
LF(C-JI5,24)
LT(C-JI5,23)
C3
RE2(CI)
REI(CI)(C-JI5,8)
RE3(C2)
DTOUTI(C-SI,E2)
DTOUT2(C-SI,E3)
DTOUT3(C-SI,E4)
DTOUT4(C-SI,E5)
DTOUT5(C-SI,E6)
REI(C-JI5,9)
RE2(C2)
C-SI SWITCH POSITIONS
GATE TIME
100µs 1
1ms 10
10ms 10²
100ms 10³
1s 10⁴
10s 10⁵
TIME INTERVAL
C-JI6
PIN NO
D-PI6
E32(CI)
E38(CI)
E22(CI)
E21(CI)
E24(CI)
E28(CI)
E12(CI)
E11(CI)
E14(CI)
E18(CI)
E74(C2)
E72(C2)
E71(C2)
E78(C2)
+5V
E31(CI)
E34(CI)
E44(CI)
E48(CI)
E42(CI)
E41(CI)
E58(C2)
E54(C2)
E52(C2)
E51(C2)
E64(C2)
E62(C2)
E61(C2)
E68(C2)
CG(C-JI5,3)
JACK C-JI7
WTI
D
INTERCONNECTION DIAGRAM ABCD

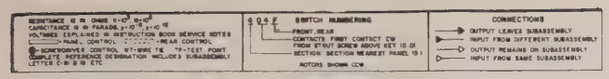

RESISTANCE IS IN OHMS, K=10^3, M=10^6
CAPACITANCE IS IN FARADS, μ=10^-6, μμ=10^-12
VOLTAGES EXPLAINED IN INSTRUCTION BOOK SERVICE NOTES
PANEL CONTROL
REAR CONTROL
SCREWDRIVER CONTROL
TP=TEST POINT
COMPLETE REFERENCE DESIGNATION INCLUDES SUBASSEMBLY LETTER C-IN B-IN ETC
SWITCH NUMBERING
FRONT, REAR
CONTACTS FIRST CONTACT CW FROM STRUT SCREW ABOVE KEY 1 IS 01
SECTION, SECTION NEAREST PANEL IS 1
ROTORS SHOWN CCW
CONNECTIONS
OUTPUT LEAVES SUBASSEMBLY
INPUT FROM DIFFERENT SUBASSEMBLY
OUTPUT REMAINS ON SUBASSEMBLY
INPUT FROM SAME SUBASSEMBLY

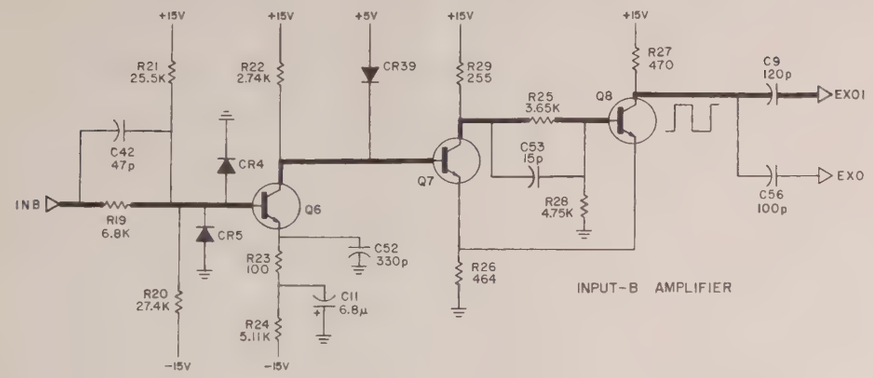
TRANSISTOR BASE DIAGRAMS

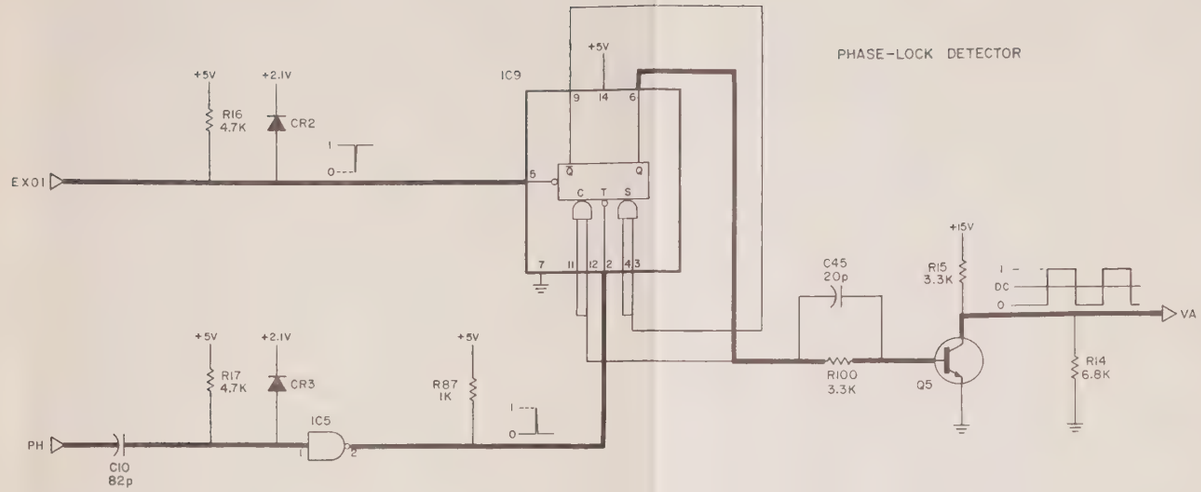
POWER SUPPLY CIRCUIT

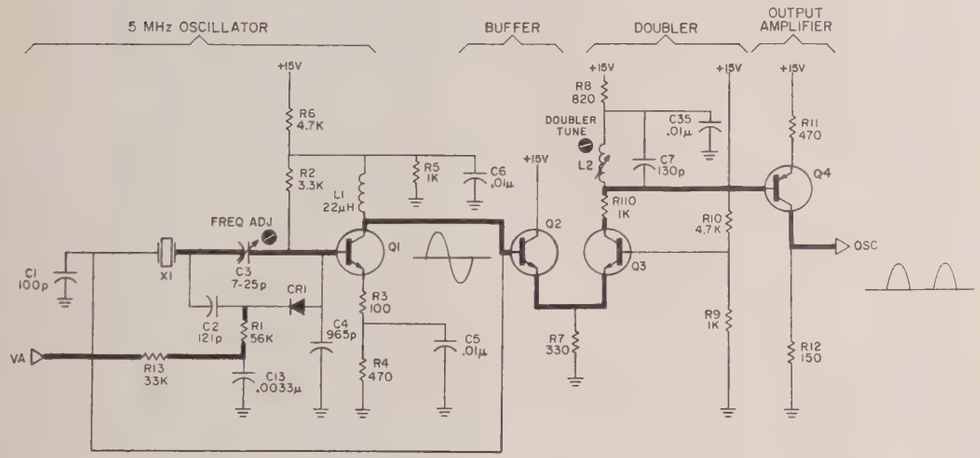


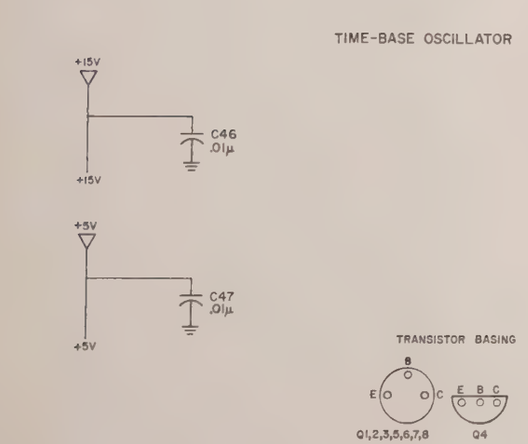
PROGRAM BOARD B

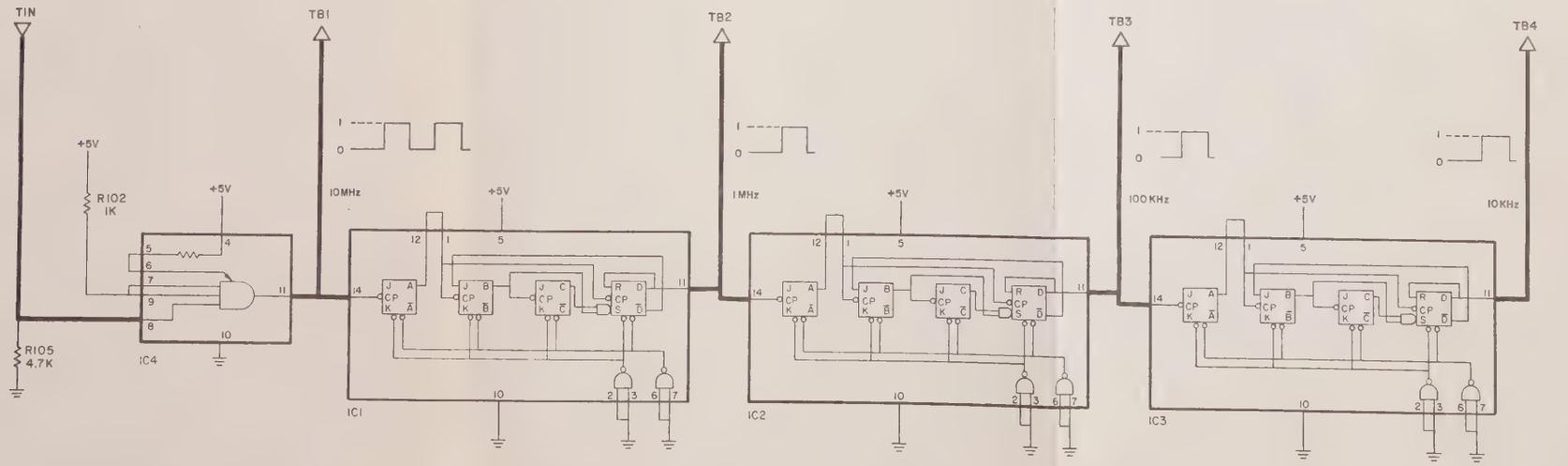




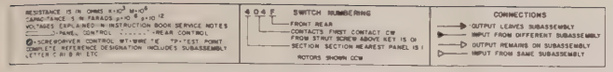




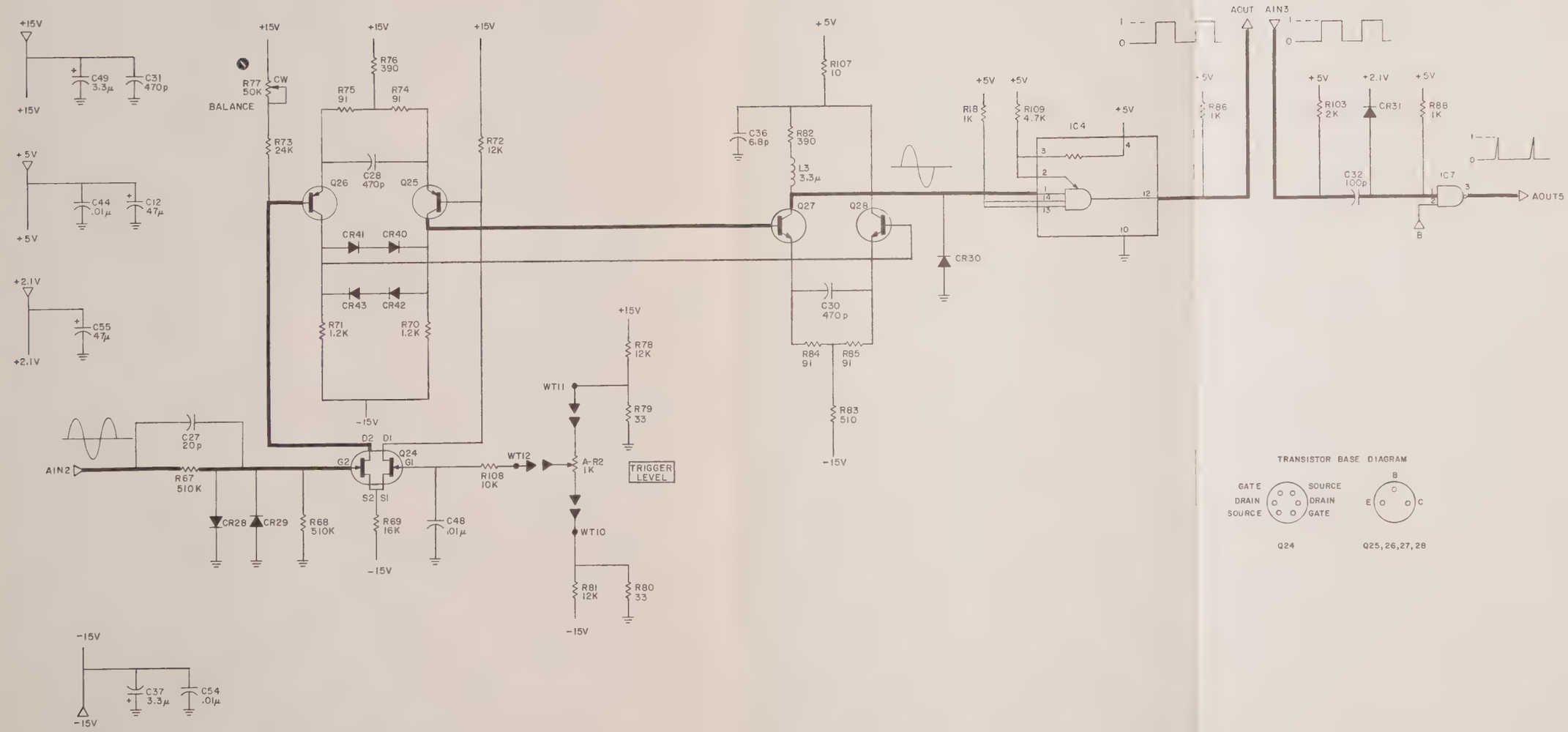




PROGRAM BOARD B

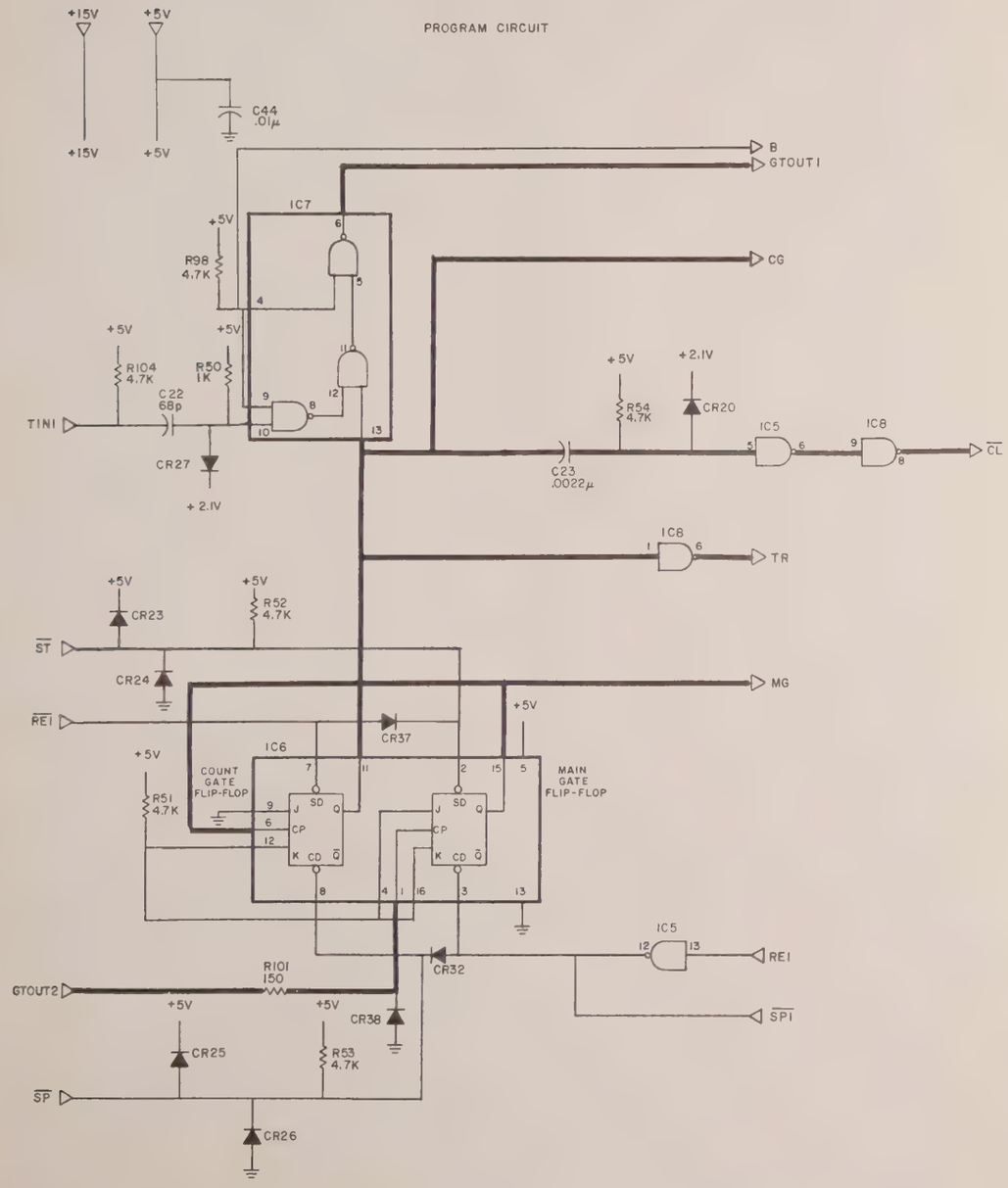

RESISTANCE IS IN OHMS K=10³ M=10⁶
CAPACITANCE IS IN FARADS μ=10⁻⁶ p=10⁻¹²
VOLTAGES EXPLAINED IN INSTRUCTION BOOK SERVICE NOTES
PANEL CONTROL
REAR CONTROL
SCREWDRIVER CONTROL WT=WIRE TIE TP=TEST POINT
COMPLETE REFERENCE DESIGNATION INCLUDES SUBASSEMBLY LETTER C A1 B A1 ETC
4 0 4 F SWITCH NUMBERING
FRONT REAR
CONTACTS FIRST CONTACT CW FROM STRUT SCREW ABOVE KEY IS 01
SECTION SECTION NEAREST PANEL IS 1
ROTORS SHOWN CCW
CONNECTIONS
OUTPUT LEAVES SUBASSEMBLY
INPUT FROM DIFFERENT SUBASSEMBLY
OUTPUT REMAINS ON SUBASSEMBLY
INPUT FROM SAME SUBASSEMBLY

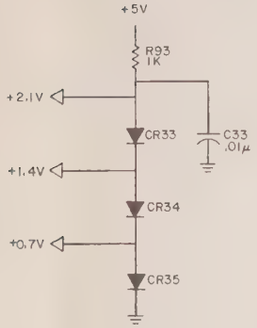
INPUT-A CIRCUIT

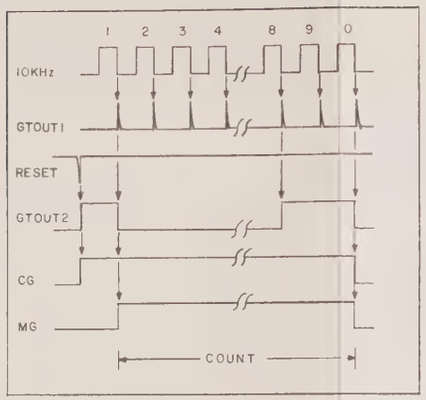


TRANSISTOR BASE DIAGRAM

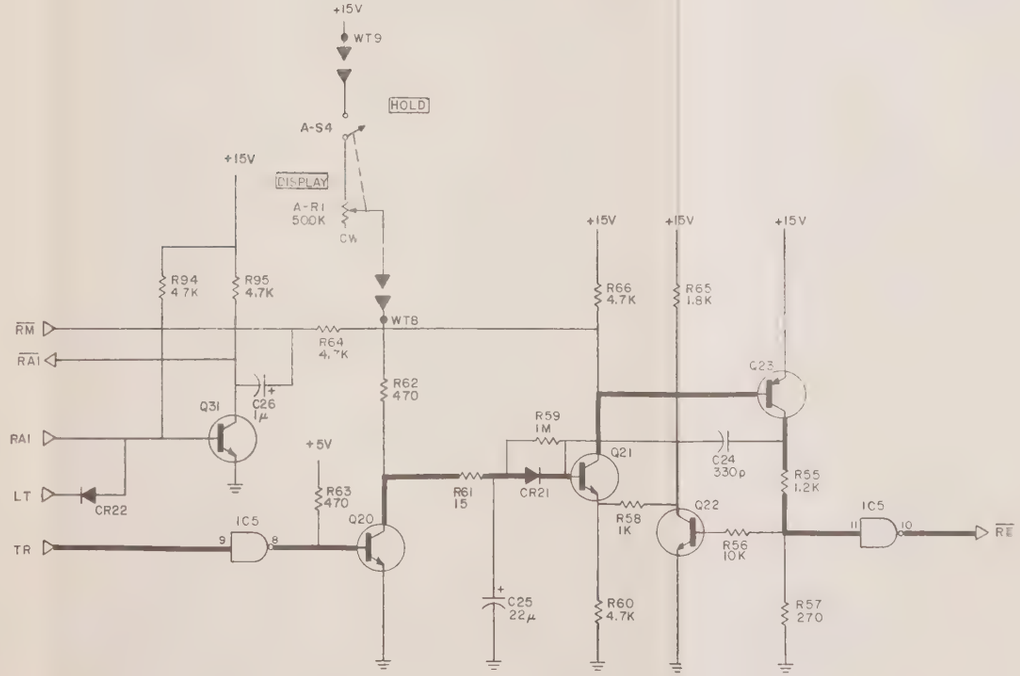
PROGRAM CIRCUIT



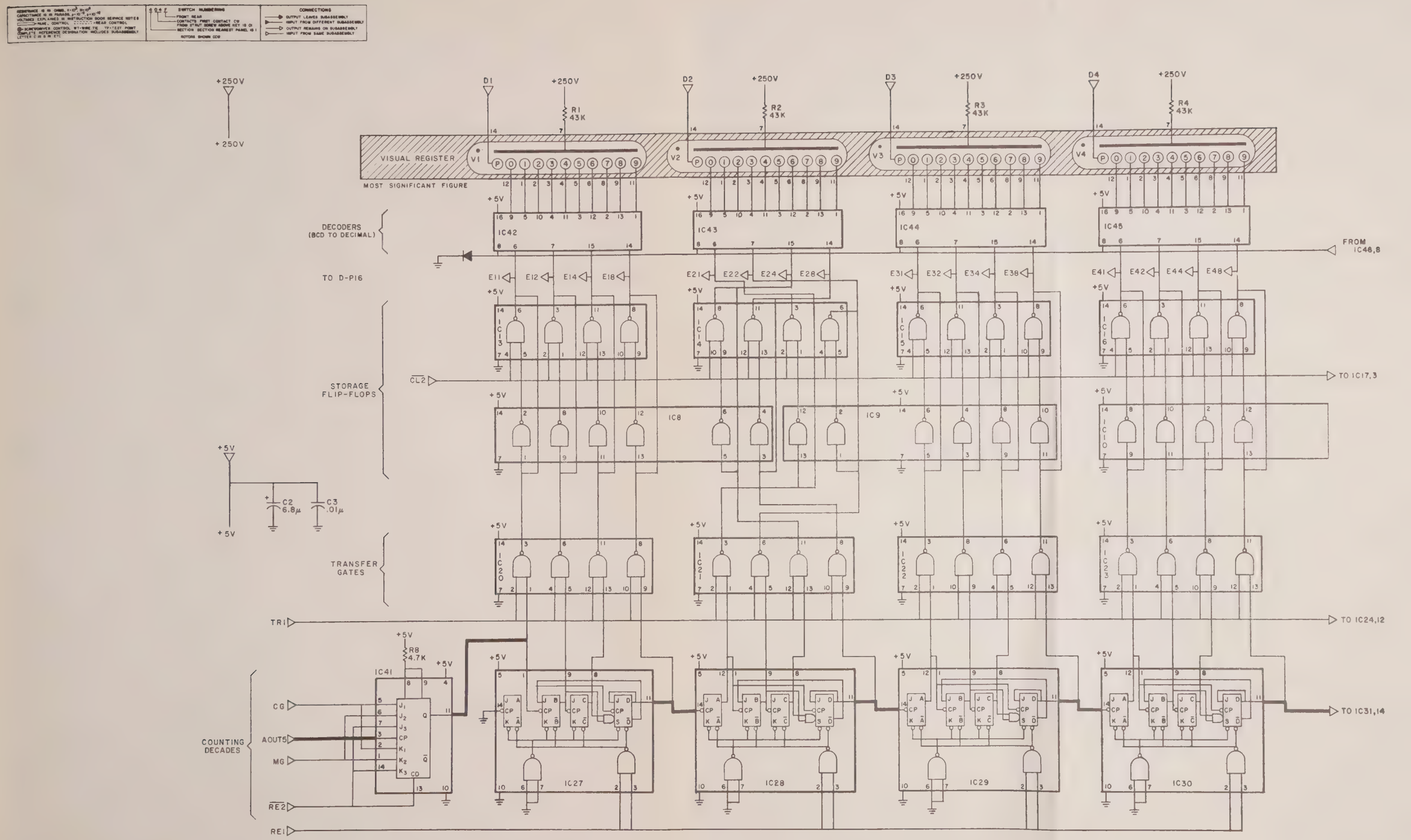




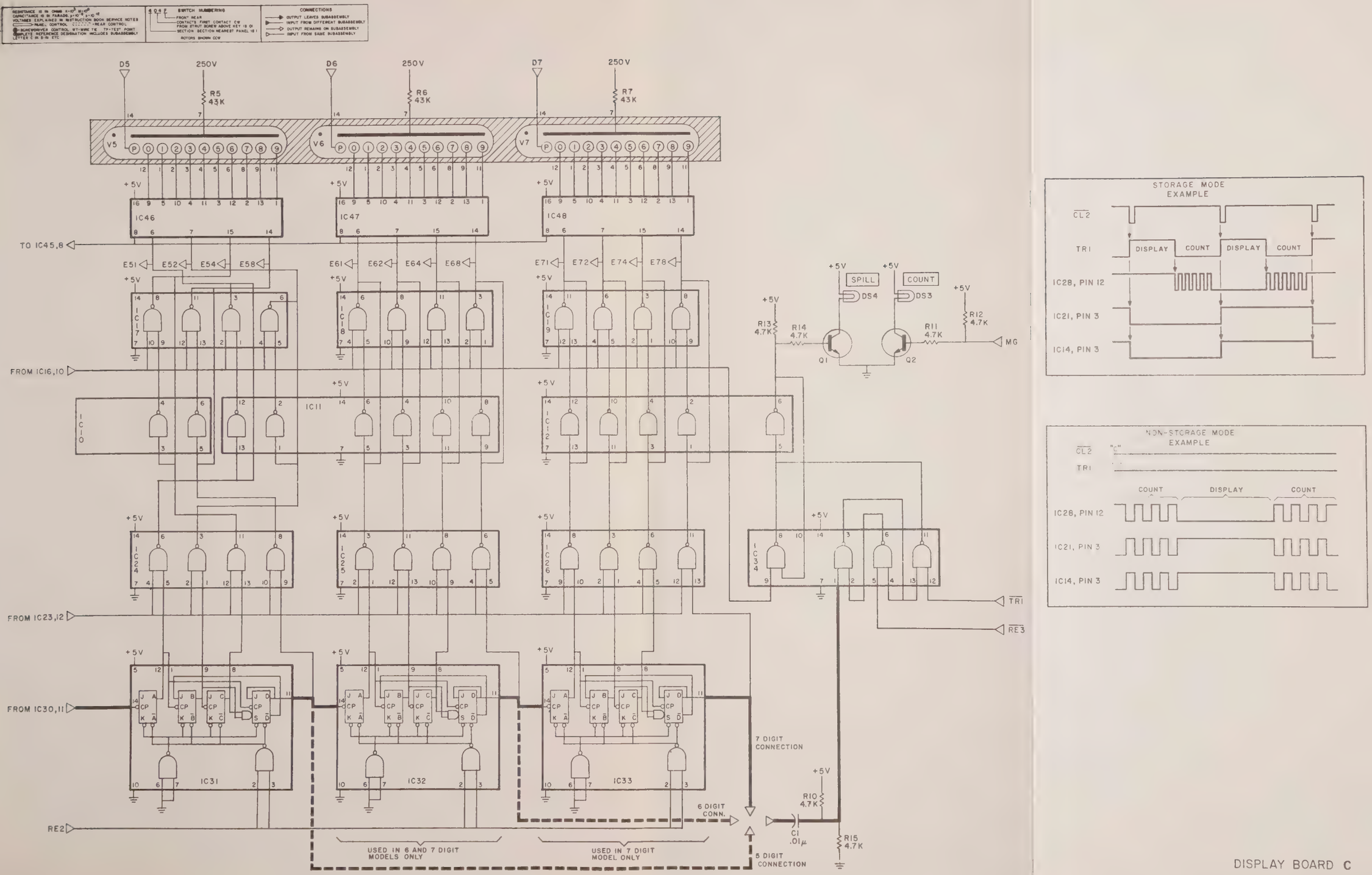
TRANSISTOR BASE DIAGRAM



DISPLAY CIRCUIT

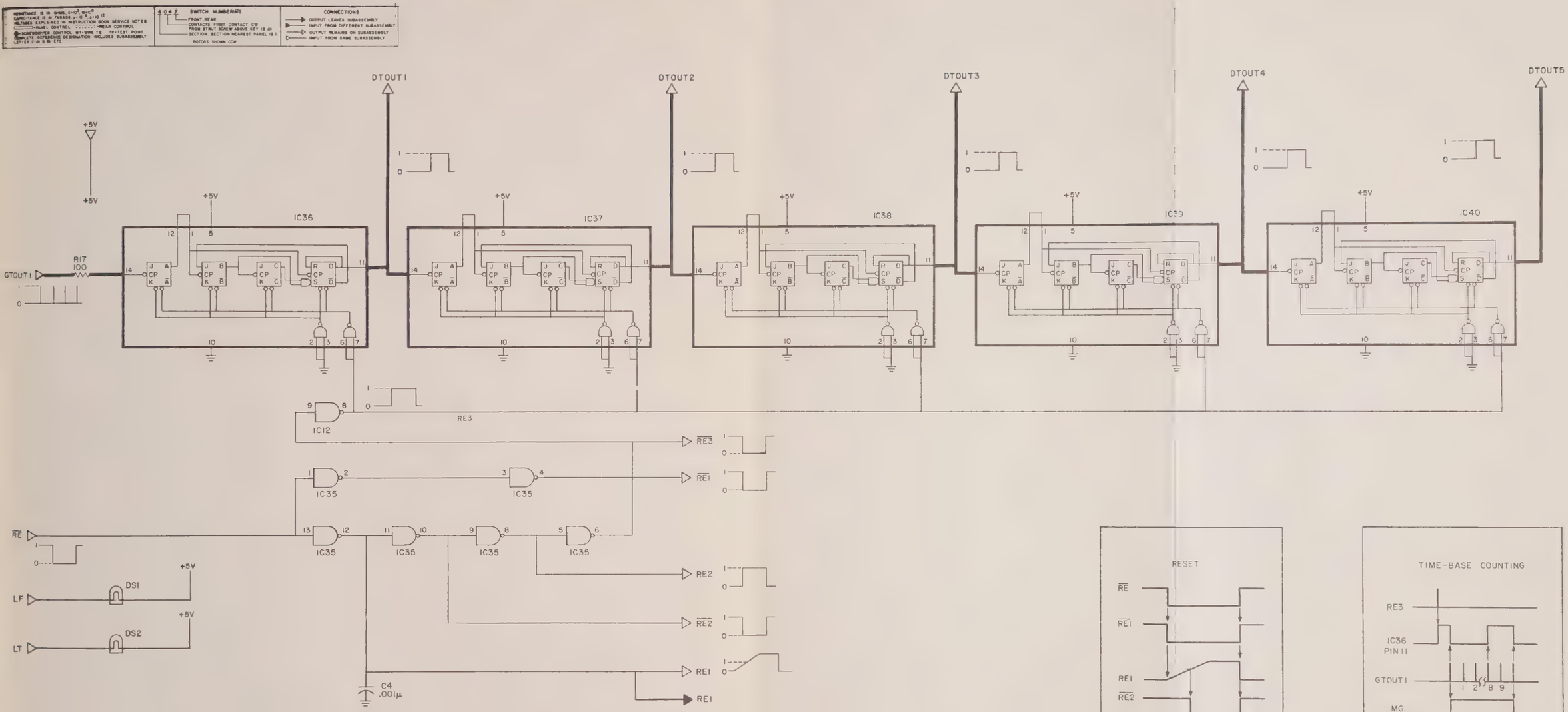


DISPLAY BOARD C

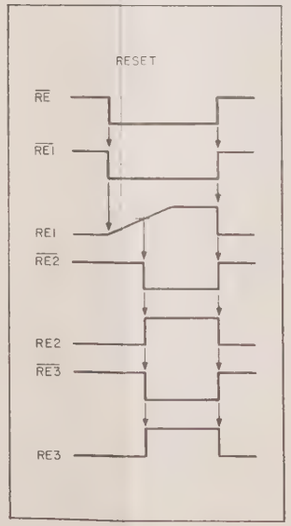

D5
D6
D7
250V
R5 43K
R6 43K
R7 43K
V5
V6
V7
IC46
IC47
IC48
TO IC45,8
FROM IC16,10
FROM IC23,12
FROM IC30,11
RE2
IC31
IC32
IC33
7 DIGIT CONNECTION
6 DIGIT CONN.
5 DIGIT CONNECTION
USED IN 6 AND 7 DIGIT MODELS ONLY
USED IN 7 DIGIT MODEL ONLY
SPILL
COUNT
DS4
DS3
R13 4.7K
R14 4.7K
R11 4.7K
R12 4.7K
Q1
Q2
MG
TRI
RE3
R10 4.7K
C1 .01μ
R15 4.7K

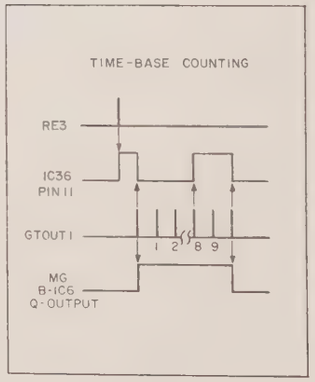
STORAGE MODE EXAMPLE
CL2
TRI
DISPLAY
COUNT
DISPLAY
COUNT
IC28, PIN 12
IC21, PIN 3
IC14, PIN 3

NON-STORAGE MODE EXAMPLE
CL2
TRI
COUNT
DISPLAY
COUNT
IC28, PIN 12
IC21, PIN 3
IC14, PIN 3



TIME BASE DIVIDER CIRCUIT





DISPLAY BOARD C

RESISTANCE IS IN OHMS, K=10³, M=10⁶
CAPACITANCE IS IN FARADS, μ=10⁻⁶, μμ=10⁻¹²
VOLTAGES EXPLAINED IN INSTRUCTION BOOK SERVICE NOTES
PANEL CONTROL
REAR CONTROL
SCREWDRIVER CONTROL
ST-WIRE TIE
TP-TEST POINT
COMPLETE REFERENCE DESIGNATION INCLUDES SUBASSEMBLY LETTER, C-M, G-M, ETC.
SWITCH NUMBERING
FRONT-REAR
CONTACTS, FIRST CONTACT CW FROM STRUT SCREW ABOVE KEY IS 01
SECTION, SECTION NEAREST PANEL IS 1
ROTORS SHOWN CCW
CONNECTIONS
OUTPUT LEAVES SUBASSEMBLY
INPUT FROM DIFFERENT SUBASSEMBLY
OUTPUT REMAINS ON SUBASSEMBLY
INPUT FROM SAME SUBASSEMBLY

DATA OUTPUT

D-J1

DECADE 7

D78 39 — E78 — IC5 pin 13 — IC5 pin 12
D74 38 — E74 — IC4 pin 5 — IC5 pin 6
D72 14 — E72 — IC5 pin 9 — IC5 pin 8
D71 13 — E71 — IC5 pin 11 — IC5 pin 10

DECADE 6

D68 37 — E68 — IC5 pin 5 — IC5 pin 6
D64 36 — E64 — IC4 pin 13 — IC4 pin 12
D62 12 — E62 — IC5 pin 1 — IC5 pin 2
D61 11 — E61 — IC5 pin 3 — IC5 pin 4

DECADE 5

D58 35 — E58 — IC3 pin 11 — IC4 pin 10
D54 34 — E54 — IC3 pin 13 — IC3 pin 12
D52 10 — E52 — IC4 pin 9 — IC3 pin 8
D51 9 — E51 — IC4 pin 11 — IC4 pin 10

DECADE 4

D48 33 — E48 — IC2 pin 11 — IC2 pin 10
D44 32 — E44 — IC2 pin 9 — IC2 pin 8
D42 8 — E42 — IC2 pin 13 — IC2 pin 12
D41 7 — E41 — IC3 pin 9 — IC3 pin 8

DECADE 3

D38 31 — E38 — IC1 pin 13 — IC1 pin 12
D34 30 — E34 — IC1 pin 9 — IC1 pin 8
D32 6 — E32 — IC1 pin 11 — IC1 pin 10
D31 5 — E31 — IC1 pin 5 — IC1 pin 6

DECADE 2

D28 29 — E28 — IC3 pin 1 — IC3 pin 2
D24 28 — E24 — IC2 pin 5 — IC2 pin 6
D22 4 — E22 — IC2 pin 1 — IC2 pin 2
D21 3 — E21 — IC2 pin 3 — IC2 pin 4

DECADE 1

DI8 27 — E18 — IC4 pin 3 — IC4 pin 4
DI4 26 — E14 — IC4 pin 1 — IC4 pin 2
DI2 2 — E12 — IC3 pin 3 — IC3 pin 4
DI1 1 — E11 — IC3 pin 5 — IC3 pin 6

D-P16

PGT 24 — IC1 pin 2 — IC1 pin 1
+5V 25
GND 50
GND (PIN 14 ON IC1,2,3,4,5)
+5V (PIN 7 ON IC1,2,3,4,5)
WT1
CG — WIRE JUMPER — +5V — GND
D-P16

DATA OUTPUT BOARD D

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